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ABSTRACT

This report describes a program for enhancing direct teaching using creative memorization strategies in order to improve retention and quick retrieval of math facts. The targeted population consisted of first and second grade students in two separate districts in middle class communities. Analysis of probable cause data revealed that students were having difficulty memorizing math facts. Reviews of curricula content and instructional strategies revealed an increase in mathematical content, thereby limiting time spent on each concept. Reviews also revealed students lacked retention of math facts and transfer skills. A review of solution strategies suggested by professional literature combined with an analysis of the problem setting resulted in the analysis of three major categories of intervention: Touch Math, multiple intelligences, and use of mnemonics to increase the amount and quality of retention in the first and second grade classrooms. Post intervention data indicated a substantial increase in student retention and retrieval of math facts, a decrease in student use of manipulatives to solve math equations, and fluctuation in parent survey results. Appendixes include: four selected worksheets on addition and subtraction from "Mad Minute" (Addison Wesley Publishing Company, Inc., 1981); Student Survey; and two Parent Surveys. (Contains 60 references and 32 figures.) (Author/MM)

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Effects of Direct Teaching Using Creative Memorization Strategies to Improve Math Achievement

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Saint Xavier University & IRI/Skylight
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ABSTRACT

This report describes a program for enhancing direct teaching using creative memorization strategies in order to improve retention and quick retrieval of math facts. The targeted population consisted of first and second grade students in two separate districts in middle class communities.

Analysis of probable cause data revealed that students were having difficulty memorizing math facts. Reviews of curricula content and instructional strategies revealed an increase in mathematical content, thereby limiting time spent on each concept. Reviews also revealed students lacked retention of math facts and transfer skills.

A review of solution strategies suggested by professional literature combined with an analysis of the problem setting resulted in the analysis of three major categories of intervention: Touch Math, multiple intelligences, and the use of mnemonics to increase the amount and quality of retention in the first and second grade classrooms.

Post intervention data indicated a substantial increase in student retention and retrieval of math facts, a decrease in student use of manipulatives to solve math equations, and fluctuation in parent survey results.

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

The students of the targeted first and second grade classrooms exhibit difficulty in retaining math skills. Evidence for the existence of the problem includes teacher designed assessments, teacher observations, and Mad Minutes.

Immediate Problem Context

Site A

Site A consists of 519 students ranging in age from kindergarten through fifth grade. The ethnicity of the students is 83.2% White, 12.1% African American, 3.6% Hispanic, 1.1% Asian American/Pacific Islander, and 0.0% Native American. Site A is one of four elementary schools located in the district with a total enrollment of low-income families being 0.4% and there is 0.0% Limited-English-Proficient families. The attendance of students in Site A is 95.7% with the student mobility being 4.2% with 0.0% chronic truancy. According to the School Report Card, Site A has an average class size of 25.3 students for each of the first and second grade classrooms. In this school there is 100% communication from the parents through either parent/teacher conferences, telephone and written messages, or through visitation (School Report Card, 1999).

This building is over 50 years old and is the largest of the four elementary schools in its district. There are 22 certified classroom teachers, three special education teachers, one speech/language teacher, and one social worker. The instructional aides are hired according to the needs and abilities of the students designated by their Illinois Education Plan (IEP) and when the class size exceeds 25 students. Each grade level has four classrooms in which the students are placed heterogeneously. The time devoted to the core subjects is 60 minutes for mathematics, 30 minutes for science, 155 minutes for English, and 30 minutes for social sciences. In addition to the core subjects, students spend 60 minutes a week in each of the following Fine Arts classes: music, art, and physical education. Also, there are two 30 minute sessions a week spent in both the computer lab and the library.

One of the various programs that are offered to low achieving students in Site A is an after school tutoring program. The program is based on teacher recommendation, previous interventions, and the student's ability level. The students receiving these tutoring services may not have an IEP. Another option for low achieving students is summer school. The placement for summer school is based on the students' scores from Iowa Tests of Basic Skills in math and reading. Students must be in the third stanine or below in these core subjects to be allowed to participate in summer school.

The district is considered large with 2,324 students and 162 teachers. The ethnic breakdown of the teacher population is 90.7% White, 8.7% African American, 0.6% Asian American/Pacific Islander, 0.0% Hispanic, and 0.0% Native American. There are 78.3% female teachers and 21.7% male teachers. The average teaching experience in the

district is 15.2 years. The percentage of teachers with a master's degree and above is 60.3%. The average teacher salary is $43,162 and the average administrative salary is $71,464. There are 16.3 students for every one teacher and 290.5 students for every one administrator (School Report Card, 1999).

The Surrounding Community

Community A, located 45 minutes away from a large metropolitan area, was established in 1924. According to U.S. Census Bureau projections, it has an estimated population of 9,340 people. In the community 9,340 people 51.6% are female and 48.4% are male. The racial distribution is 84.2% White, 10.5% African American, 0.1% Hispanic, and 5.2% other.

The U.S. Census Bureau cited the median price of a home in October-December, 1999 to be $162,500. The median family income is $139,786 (Chicago Tribune.com, 2000).

The educational background of Community A is 12.3% with high school degrees, 20.3% with a college background, 5.1% with an associates degree, 29.0% with a bachelor's degree, and 28.2% with a graduate degree. The median years of school completed are 15.4. In this community 63.3% of the population are employed, 2.1% are unemployed, and 34.6% are not in the labor force. Of those employed, the occupations are as follows: 58.1% managerial/professional, 17.1% sales, 10.9% administrative support, 5.1% service, 2.7% technicians, 2.3% craft repair, 1.4% factory, 1.1% helpers/laborers, 1.0% transportation, and 0.3% agriculture (Chicago Tribune.com, 2000).

In this community there is an abundance of activities that encourage participation from the students. Some of the activities that are offered are fishing, fitness programs, swimming lessons, arts and crafts, and field trips. There are 31 park sites that maintain 209 acres of land. The park facilities include 25 tennis courts, an indoor ice arena, swimming pools, a nature center, 12 soccer fields, and 21 baseball diamonds. The public library has an extensive collection of books for children as well as compact disks, audiocassettes, and books on tape. There is also a computer lab available to students with Internet access. Special activities throughout the year are offered such as reading clubs, story times, book discussion groups, and preschool story times. During the summer, camp programs are offered and there are two public pools with waterslides (Village Profile.com, 2000).

Immediate Problem Context

Site B

Site B is one of two elementary schools in the district. This elementary school houses 386 students with grades ranging from preschool through fourth grade. Of the 386 students, 41.0% of them are White, 45.7% are African American, 9.3% are Hispanic, 2.1% are Asian American/Pacific Islander and 1.8% are Native American. Of the 386 students, 40.0% are low-income and 0.0% have Limited-English-Proficiency. There is no chronic truancy with an attendance rate of 93.5%. The mobility of the targeted school is 9.3% (School Report Card, 1999).

In Site B students are heterogeneously assigned into a classroom. The average class size ranges between 24.3 in kindergarten, 28.0 in first grade, and 27.7 in third grade. In Site B there are 18 classroom teachers, two special education teachers, and four

teacher aides. A physical education teacher, art teacher, music teacher, a psychologist, and a social worker are also assigned to work directly with the students. The time allocation per subject is 140 minutes for reading and language arts, 60 minutes for math, 40 minutes for science, and 40 minutes for social studies. In addition to the core subjects, the students receive four 25-minute periods of physical education, two 25-minute periods of music, two 25-minute periods of computers and one 50-minute period of art.

The school offers FoCuS on Families, Community, and School Organized and United for the 21st Century (FoCuS). FoCuS addresses reading, writing, and math skills. Students meet with other students in their grade level three times a week for an hour after school. This program attempts to strengthen those skills lacking among those students in these areas. FoCuS was designed for at-risk students because they were not getting the help they needed. Teachers felt strongly that more time on task for the students in a small group format would be beneficial. Three teachers wrote and received an Urban Education grant to keep FoCuS in the school for the next three years. Site B also has 100% of contact between students' parent/guardians and teachers. Contact between teacher and students' parents/guardians include parent/teacher conferences, parental visits to school, home visits, telephone or through written communication (School Report Card, 1999).

Site B is part of a medium elementary district. There are 79 teachers in the district. Of these 79 teachers, 87.3% are White, 11.4% are African American, and 1.3% are Hispanic. Of these 79 teachers 83.5% are female and 16.5% are male. The average teaching experience is 15.5 years, and 29.7% of the teachers have their master's degree

and above. Of the district the student-teacher ratio is 17.5:1, and the student-certified staff ratio is 13.5:1 (School Report Card, 1999).

The Surrounding Community

The students in Site B come from a small midwestern town located 45 minutes from a large metropolitan area. The U.S. Census Bureau has estimated the community to have 8,979 people. Of the 8,979 people in the community, 71.5% are White, 25.35% are African American, 2.1% Hispanic, and 1.1% are other. However, the community demographics do not accurately reflect the school's demographics. There are students who attend the school who live in a neighboring community. A majority of these students reside in Section 8 housing. Females comprise 52.7% and males account for 47.3% of the community population. In the community of 8,979 people 65.8% are employed, 3.8% are unemployed, and 30.4% are not in the labor force. Of the people in the community that are employed, 30.2% are managerial/professional, 20.9% administrative, 13.0% sales, 12.0% craft/repair, and 23.9% other. The median family income is $77, 829. As for education, 28.4% have obtained a high school diploma, 25.9% have attended college, 7.3% have an associate's degree, 15.3% have a bachelor's degree and 8.4% have a master's degree (Chicago Tribune.com, 2000).

While Community A has an abundance of activities that are offered to their students, Community B has limited activities available to their students. A few activities Community B provides are: Girl Scouts, Boy Scouts, sports programs, a few small parks, and a library that has a variety of programs. This leaves few options for outside school activities.

National Context of the Problem

Everyday, Americans have difficulty with memorization of math skills. This problem may have originated from a lack of memorization skills during their elementary years. Research shows there is a concern about students' achievement in math. One factor may be that educators may have negative attitudes about teaching mathematics; therefore, those teachers' attitudes are projected towards their students. These attitudes are usually established in the early grades and may be difficult to change in later years (Kolstad & Hughes, 1994).

Another reason students may have difficulty with mathematics is that teachers are not aware of how the brain works. According to Sprenger, "The brain has everything to do with learning, and the more we know about brain science, the easier it will be to make the hundreds of decisions each day that affect our students" (1999, p. vi). When teachers know about the brain and how the memory works, they will become more effective in the field of education.

While U.S. achievement has risen across our nation, we still lag behind our international competitors. It is important that we, as a nation, take steps to improve mathematics education for kindergarten through 12th-grade (Johnson, 1999). For example, the Chinese students' scores on computation put them far ahead of American students. Students in the Asian culture learn computation of math skills through rote learning, board work, whole class direct instruction, and drill (Bracey, 1996). The author implies that although this proves effective for the Asian culture, American students may need a more creative approach to rote memorization.

Many students do not have the background to go beyond simple computation. Students are lacking in memorization of basic skills and showing poor scores on math tests. Addition and subtraction should be the building blocks for mathematical mastery. If students do not master these basic skills, then students lack the ability to solve more complex math problems (Kantrowitz & Wingert, 1991). It is the responsibility of educators to develop a variety of teaching methods for direct instruction of basic skills.

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

In order to document the extent of lack of math competency among the targeted students, the teacher-researchers administered Mad Minute™ tests, a student survey, and a parent survey. The Mad Minute test was given to provide data on how rapidly the students could respond in the allocated amount of time. The student survey was used to gather information on the different strategies the targeted students used, and to reveal their strengths and weaknesses in math. The teacher-researchers felt that information was also needed from the parent on how often the students studied, where the studying was taking place and what strategies were being used. This data was gathered by a parent survey.

The teacher-researchers administered two Mad Minute tests (Appendix A, B, C, D) to their first and second grade students to see how quickly and accurately they could solve math facts. The second grade Mad Minute test consists of 30 addition and subtraction facts, with sums and differences to 18. The first grade test consists of 30 addition and subtraction facts, with sums and differences to 10. The second grade

students were given two minutes to complete as many facts as possible in the time allowed, whereas the first grade students were given one minute to complete their test. The researcher explained to the students that the problems could be completed in random order. After the Mad Minutes were collected, the researchers collated the correct responses. The first grade classroom at Site A (A1) consists of 22 students. The second grade classroom at Site A (A2) consists of 17 students. The first grade classroom at Site B (B1) consists of 16 students. The second grade classroom at Site B (B2) consists of 17 students. Figure 1 shows the range of correct responses and the percent of students within each category.

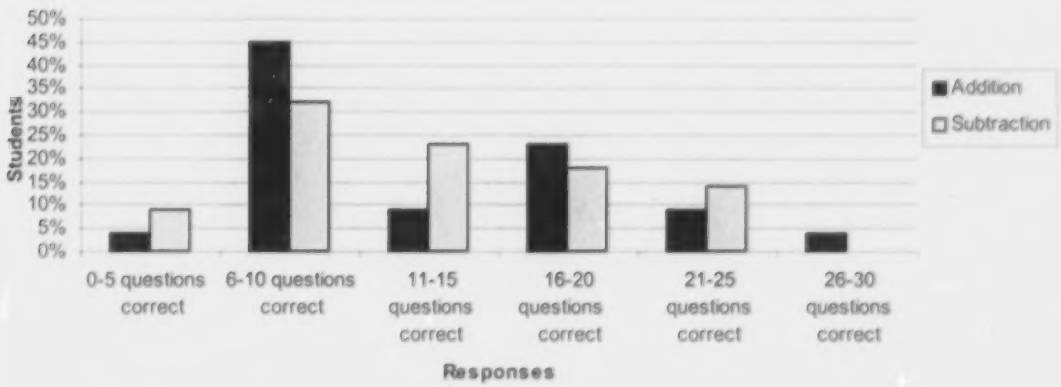


Figure 1. Mad Minutes performance in classroom A1.

Analyses of the Mad Minute scores for classroom A1 reveal that the majority of the first grade students answered 10 or less problems correctly out of the possible 30 problems. The students performed below expectations. When the Mad Minute test was given, the majority of the students should have been able to successfully complete, at least, half of the problems correctly. Furthermore, the students scored higher in addition than they did in subtraction. Subtraction is often more difficult for first graders because

they have difficulty counting backwards. The teacher needs to further develop computation in her classroom. She may want to involve the parents and create alternative materials to better improve memorization.

The researcher is classroom A2 administered the test to 17 students. Prior to the test the students have had some practice with their math facts, but none of the interventions that will be discussed later in this research were introduced. Figure 2 depicts the percent of students per category.

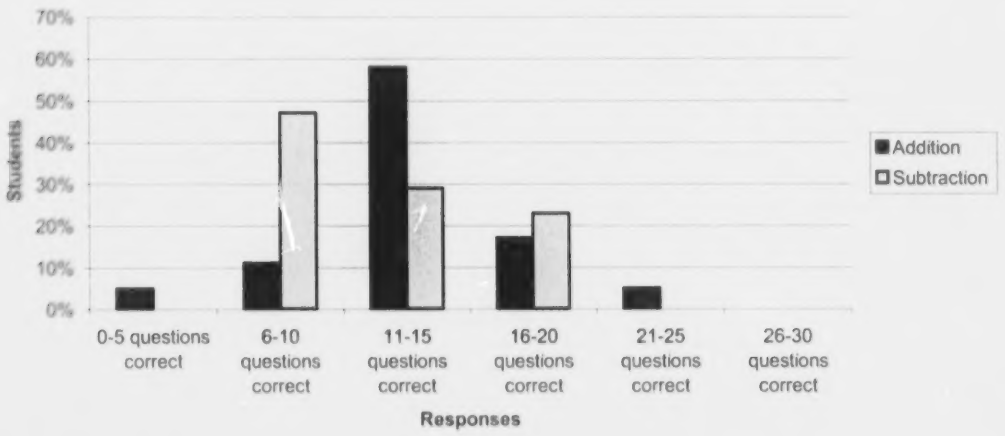


Figure 2. Mad Minutes performance in classroom A2.

The data show that students had a greater difficulty with subtraction. Students answered more addition problems correctly in the allotted time. Nearly 80% of students answered 11 or more addition problems correctly, whereas only about 55% answered 11 or more subtraction problems correctly. Only about 5% answered 21 or more addition problems correctly and 0% answered more than 25. The researchers believe teachers need to spend more time focusing on math facts with daily review, especially with subtraction, which seems to be much more difficult for the students. When teachers

spend more time on teaching strategies, the researchers believe students will be able to retrieve math facts more quickly.

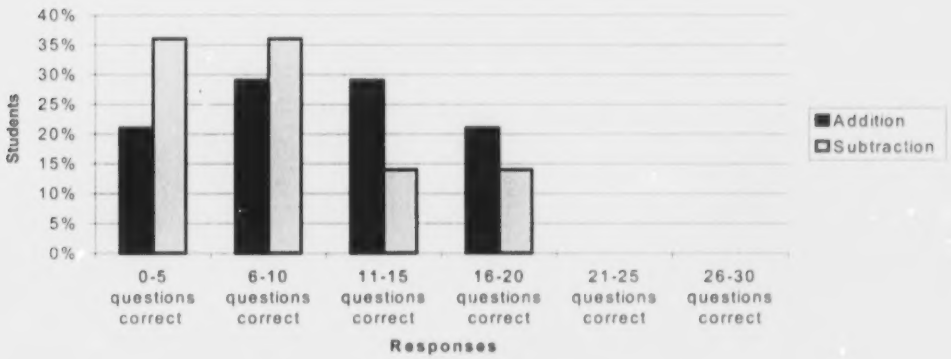


Figure 3. Mad Minutes performance in classroom B1.

The data show that more students correctly answered addition problems. This suggests that the first grade students have an easier time with addition facts than with subtraction facts. Just above 20% of the students correctly answered 16 to 20 addition questions while just below 15% of the students correctly answered 16 to 20 subtraction questions. No student achieved the goal of correctly responding to 30 questions within the allotted time frame. The majority of students fell into the 6-10, 11-15 range of correct responses for addition, and the 0-5 and 6-10 range of correct responses for subtraction. This again shows that the students have an easier time with addition than subtraction. This shows that these students need more practice and strategies to recall math facts rapidly.

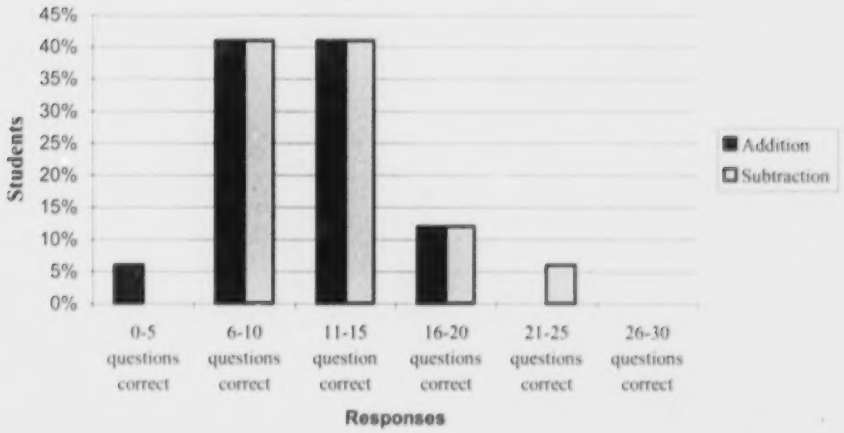


Figure 4. Mad Minutes performance in classroom B2.

An analysis of the data shows an equal amount of second grade students were able to solve the addition and subtraction problems correctly. This implies that the students find addition and subtraction equally challenging. Just above 40% of the students were able to solve 6 to 10 addition and subtraction questions correctly. The same percentage of students (40%) was able to solve 11 to 15 questions in addition and subtraction as they were able to solve 6 to 10 questions. Just below 15% of the students were able to solve 16 to 20 addition and subtraction questions correctly, and just above 5% of the students were able to solve 21 to 25 questions in subtraction correctly. The majority of the students correctly answered either 6 to 10 questions in addition and subtraction correct or 11 to 15 questions in addition and subtraction correct. The minority of students correctly answered 16 to 20 questions in addition and subtraction correct and just above 5% of the students were able to solve 21 to 25 questions in subtraction correctly. This suggests that the students find addition and subtraction problems to be at the same level of difficulty, yet there is room for improvement. The students need more practice in both addition and

subtraction to build upon what they know and improve strategies for recalling math facts more rapidly.

The researchers developed and administered a student survey, which included questions about how often students study their math facts and strategies they might use (Appendix E). Each researcher read aloud the student survey to the students.

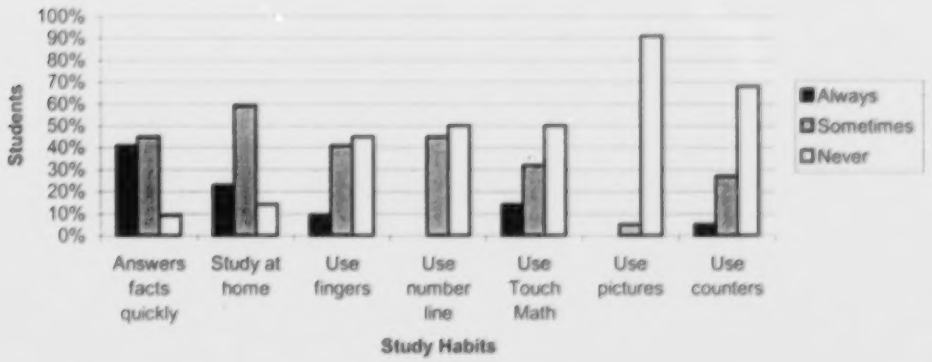


Figure 5. Student survey responses in classroom A1.

The data shows that 40% of the students surveyed in classroom A1 said that they answer math problems quickly. Only 10% of the students admit that they cannot answer the math problems quickly. The students in classroom A1 are confident in their abilities to answer math problems. However, when the students were given the Mad Minute timed test, their scores were low. There is a contradiction in what the students think they can accomplish and how they actually perform. This information tells the teacher that the students need more strategies for answering math problems. The teacher does not want to diminish their confidence, while at the same time she should teach the students alternative methods of solving their math problems.

Furthermore, 60% of the students state that they sometimes practice their math facts at home, which is consistent with the parent survey. The majority of the parents

indicated they study 2-3 times a week with their children. The students were honest about how much they study at home.

Over 40% of the students admitted to sometimes or never using their fingers to help with computation, while only 10% said they always use their fingers. Using fingers to solve math problems is common in first grade and hinders the students' ability to solve math problems quickly and accurately. Again, the teacher needs to introduce alternative ways to compute math.

Only 10% of the students use Touch Math to solve math computations. This score may be low because the students in classroom A1 had not been introduced to Touch Math in their classroom. If the student admitted to using Touch Math, that child must have learned that method somewhere else. Additionally, the majority of the class never uses pictures or counters to assist them with computation.

Overall, the students indicated that they are strong in computation and they sometimes practice computation at home. Many of the students do not feel they need other methods to solve math problems, however, their math scores are very low. The teacher needs to convey to her students that there is a variety of ways to solve math problems and that the students should feel comfortable exploring these different ways.

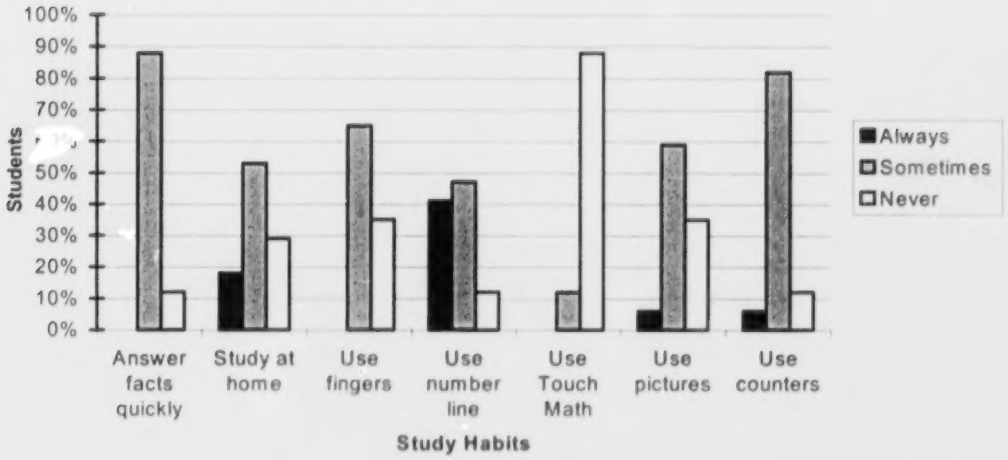


Figure 6. Student survey responses in classroom A2

The researcher in classroom A2 administered the survey to 17 students. Prior to the survey the students have had some practice with their math facts, but none of the interventions that will be discussed later in this research were introduced. Figure 6 depicts the percents of correct responses.

An analysis of the data reveals that almost all of the students say they can answer math facts quickly some of the time and only 10% responded that they never answer math facts quickly. The data show that nearly 30% of the students never study their facts at home and only about 20% always do. This suggests that there may not be much parental involvement at home, and students are not taking the responsibility to study on their own.

The data reveal students use a variety of strategies to help study math facts. Nearly 80% use counters to study sometimes and more than 50% responded to using their fingers sometimes. Almost 90% of the students do not use Touch Math to help them.

The researcher can assume this strategy had not been taught to them prior to this survey. A majority of students responded to using a variety of tools to help them with their math facts some of the time. However, less than 50% use these tools all the time.

The data imply students need to spend more time studying their math facts at home. Parental involvement should also be stressed. In addition, students need to be taught specific strategies to answer math facts quickly.

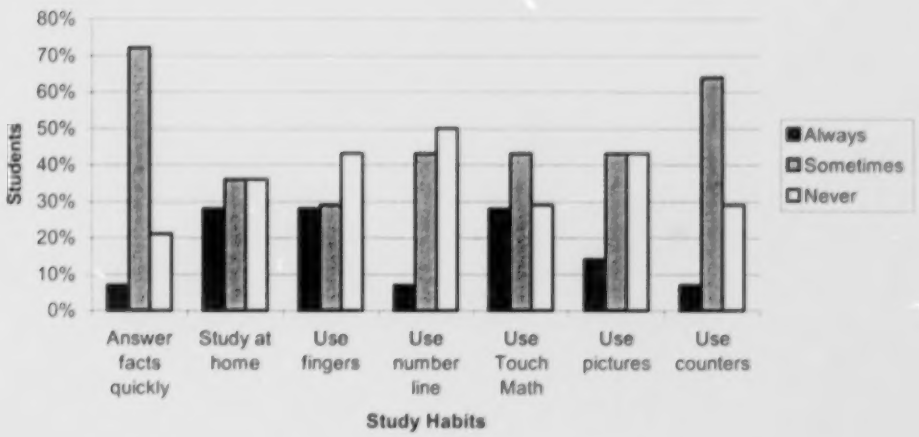


Figure 7. Student survey responses in classroom B1.

The researcher administered the survey to 16 students. Slightly over 70% of the students indicated that they answer math facts quickly some of the time. Looking at the results from the Mad Minutes, it would appear to agree with the students' assessment. Only 20% of the students replied that they never answer questions quickly. Again, looking at the Mad Minutes percentages, there were slightly fewer than 20% of the students who could correctly answer 0 to 5 questions on the addition test. The student survey shows that 70% of the students sometimes study at home or never study at home. The addition and subtraction Mad Minute results might be a reflection of the students not

using a variety of strategies to recall math facts. In the student survey, more students replied that they either sometimes or never used these strategies to help them with their math facts.

Slightly less than 30% of the students always use Touch Math and their fingers to help them with their math facts while slightly less than 10% always use a number line and counters. This implies that the students need a wider variety of strategies that they can rely on to help them quickly recall math facts.

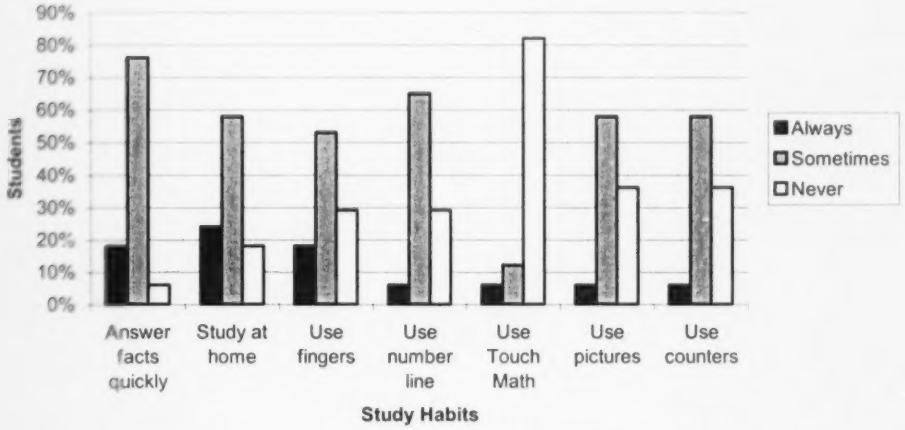


Figure 8. Student survey responses in classroom B2.

The researcher in classroom B2 administered the survey to 17 students. Prior to the survey the students have had some practice with their math facts, but only a few interventions were introduced.

An analysis of the data suggests that over 70% of the students think they can answer math facts quickly sometimes and just below 10% think they cannot answer math facts quickly. Most of the students in classroom B2 are confident in their ability to answer math problems and enjoyed taking the Mad Minute timed test. Their scores

ranged from average to high and this information suggests the students may need more strategies for answering math problems quickly and correctly.

Furthermore, just below 60% of the students' state they sometimes study their math facts at home, which is consistent with the parent survey. The majority of the parents say they study several times a week with their children, so the students were honest about how much they study at home.

Over 50% of the students admit to sometimes using their fingers to help with computation, while just below 20% say they always use their fingers. The number of students that say they never use their fingers to help them solve math problems was just below 30%. Using fingers to help with computation has become a crutch with many students and this information appears to be different than what is being observed by the teacher. Again, the teacher needs to introduce alternative methods to solve math facts.

The majority of the students do not use Touch Math to solve math computations, however, the data suggests students use a variety of strategies to help study math facts. Nearly 60% use pictures or counters to study sometimes and just over 60% responded to using their number line to solve math problems sometimes as well.

Overall, the students feel confident in their computation skills and practice them at home sometimes. Many of the students believe they do not need other methods to solve math problems, however, there is room for improvement according to the given math scores. The teacher needs to convince the students that there are many options available to solve math problems, and they should investigate these possibilities to find what is comfortable for them.

The researchers developed and administered a survey to the parents in the classrooms regarding math facts (Appendix F). Parents were asked where and how often their child studied their math facts. They were also asked how their child studies their math facts and how they help them. Each category, except where they study their facts, is depicted on a different graph.

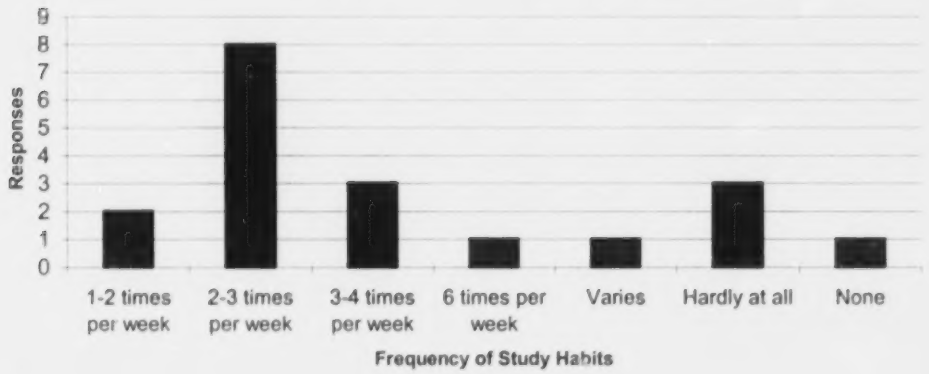


Figure 9. Parent survey responses for question one in classroom A1.

The results of the parent survey suggest the majority of the students in classroom A1 study at least 2-3 times per week. Out of 19 parents surveyed, only 1 family admitted that their child does not study math at home. The parents in classroom A1 are supportive of their children's education. There are many parents who volunteer to help in the classroom. For example, when the teacher assigns homework, most of the students complete the assignment. The teacher is able to communicate with most of the parents on a regular basis. Studying math at home is not a high priority. The teacher should communicate the importance of reinforcing the computation strategies learned in class.

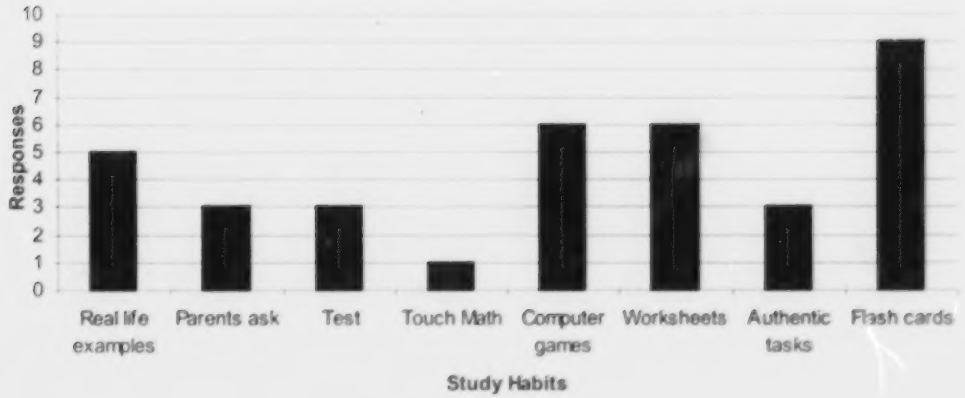


Figure 10. Parent survey responses for question 2 in classroom A1.

The majority of the parents used flash cards with their children to study math facts at home. Computer games and worksheets were the next highest category for study habits. Touch Math was used in only one child's home. The parents responded with a wide variety of methods for at home study.

For the third question on the parent survey, the teacher-researchers asked the parents where their child studies at home. The three places where the students study were the kitchen table, the child's bedroom, and the home office.

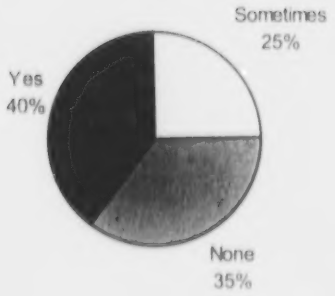


Figure 11. Percent students requiring parent help at home in classroom A1.

The data suggest that 65% of the students in classroom A1 sometimes or always require help when studying math at home. Only 35% of the students require no help. The teacher may want to further develop computation strategies to assist the 65% of the students who need assistance.

In classroom A2, a total of 8 parents responded to the survey. Figure 12 shows the number of responses per category, regarding how often their child studies their math facts at home.

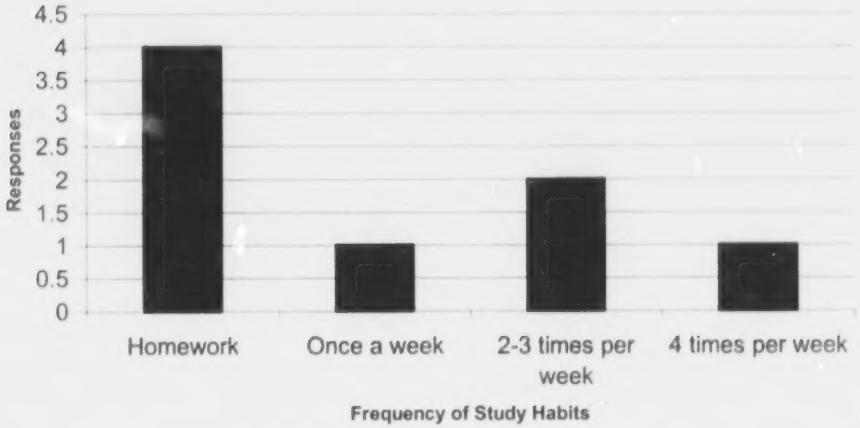


Figure 12. Parent survey responses for question one in classroom A2.

The data suggests, almost 50% of the parents responded to having their child study their facts if it was assigned as homework. They also would not study their facts if they had an ample amount of homework in other content areas. Only 1 parent responded that her child studied his math facts 4 times per week. The data imply that students are not studying their math facts as often as they should be. Students should study math facts at least 4-5 times per week in order to achieve mastery.

In classroom A2, parent responses to how their child studies their math facts is shown in Figure 13.

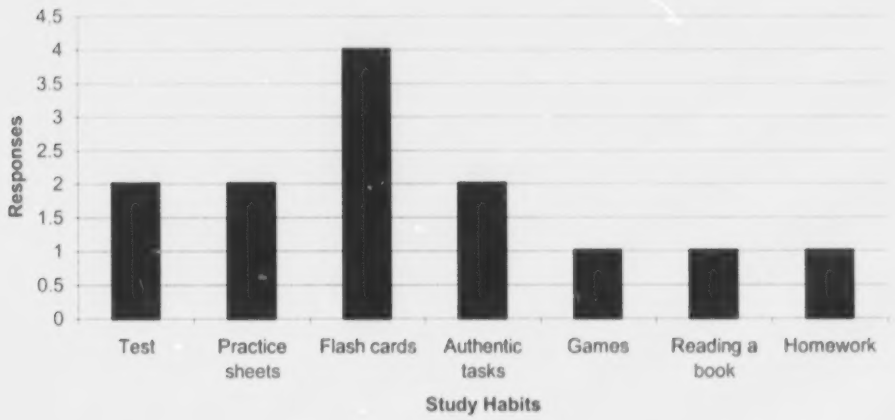


Figure 13. Parent survey responses for question 2 in classroom A2.

An analysis of the data show the greatest responses fell into the category of flash cards. Out of a total of 13 responses, 30 % responses revealed flash cards as a home intervention strategy followed by parent testing, practice sheets and authentic tasks each at 10%, followed by games, reading a book and homework support each with one response.

Out of 13 parent surveys, almost all of the parents responded to having their child study their facts at the kitchen or dining room table. Only one parent responded that their

child studies on the couch. The researcher can assume that parents usually have their children studying and doing homework at the kitchen table rather than on the couch because a television may distract them. A child may also have more room at a kitchen table and find it easier to write on a flat surface.

The final graph in classroom A2 shows the parent responses on whether their child needs help mastering their math facts.

Figure 14. Percent of students needing help with math facts in classroom A2.

The data show that about two thirds of the parents think their child occasionally needs parental support for math, and one third of the parents do not find a need to support their child in math. The data imply that more parents need to support with studying their math facts because the students have not been able to rapidly recall them. The researchers believe the more support at home with studying; the easier it will be for the students.

In classroom B1, the researcher administered the parent survey to 12 parents. The results of the survey are depicted in the following figures.

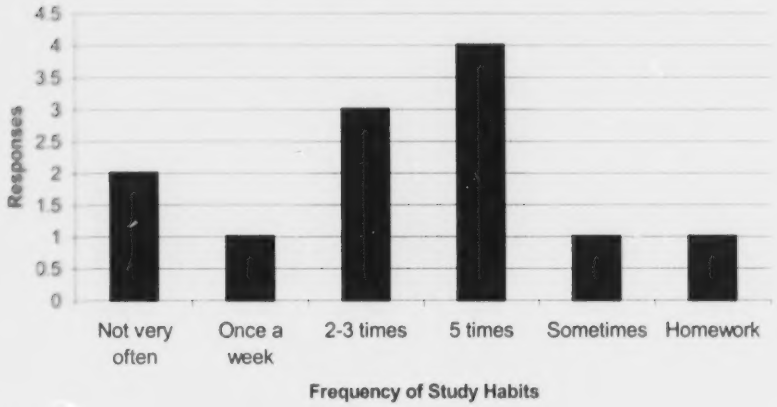


Figure 15. Parent survey responses for question one in classroom B1.

As the figure depicts, the majority of the parents replied that their students studied either 2-3 times a week or 5 times a week. Out of the 12 parents surveyed, 7 felt that their students practiced math facts 2 to 5 times a week. Another three parents felt that their student either studied once a week or not very often. The fact that only slightly above 50% of the parents felt that their students studied more than two times a week might be a result of the small amount of questions the students answered correctly. Only one parent responded that their student studied through homework. The researcher can assume that the homework is sent home at least four times a week, and that the homework contains some type of math fact review. Assuming this fact would lead the researcher to question why there is so few parents responding that their students study math facts at least four times a week.

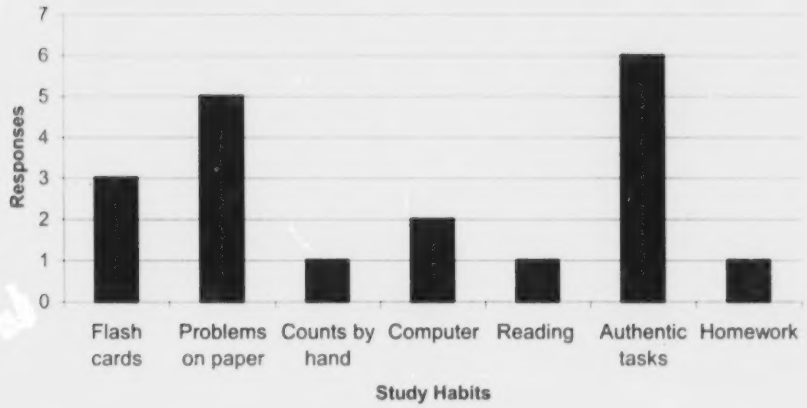


Figure 16. Parent survey responses for question 2 in classroom B1.

This figure shows a variety of methods used to study math facts. Out of the 19 responses, the survey showed that 6 parents use authentic tasks to help their students' master math facts. Authentic tasks can be money, sticks, and counters to name a few. There were five parents who said they put problems on paper to help their children study math facts. According to the data only two students used a computer to help them study. The researchers found this data surprising because they felt that computers might be used more often. A possible reason for this could be the demographics; using paper or authentic tasks might be more readily available.

The methods used by the fewest people were: counts by hand, reading, and homework. This survey was given to parents of first graders and the researcher assumes that most first graders cannot read with fluency. For that reason the researcher assumes that students are unable to read for information to help them solve math problems. The researchers were slightly concerned with the lack of homework used to study math facts. They had assumed that the teacher gave homework every night to the students. This was a concern in the previous question answered by the parents on the amount of studying

done by their students. Hopefully this study will give the students more methods to help them master math facts.

The third question on the parent survey was asking where the students studied their math facts at home. Seventy-five percent of the parents responded that their students used the dining room table, the kitchen, or the student's room as their place for studying. One parent made a note that their student studied while their other siblings were studying at the kitchen table. Another parent made a note that there was no music or television permitted because that could be a distraction. One parent replied that their student used the computer as their place for studying. Another parent replied that their student studied all over the house and in the car whatever was convenient that might help them learn about math.

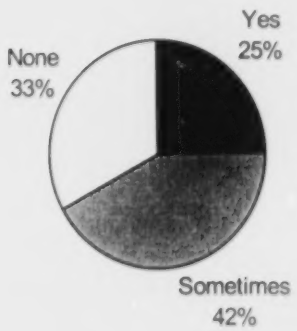


Figure 17. Percent of students needing help mastering math facts according to parent survey in classroom B1.

Most of the parents replied that their students either needed help or needed no help. According to the data one-third of the parents never helped their students with mastering math facts. The lack of studying at home might have resulted in less than 60% of the students getting 15 or fewer questions correct on the addition portion of the mad minutes. While 25% of the parents helped their students with mastering math facts, some parents said their students needed reminders of how they learned the math facts at school. One parent said that she observed the way the teacher teaches the math facts, and attempted to continue using that method to keep her student's learning consistent. An analysis of this data shows that the lack of studying at home might be a result of low mastery of math facts. The parents also replied that 42% of the parents sometimes help their students. Between the students who get some help and the students who get help often, the researcher is encouraged that they will see growth in almost all of the students. The researcher inferred from this that the parents are using the strategies.

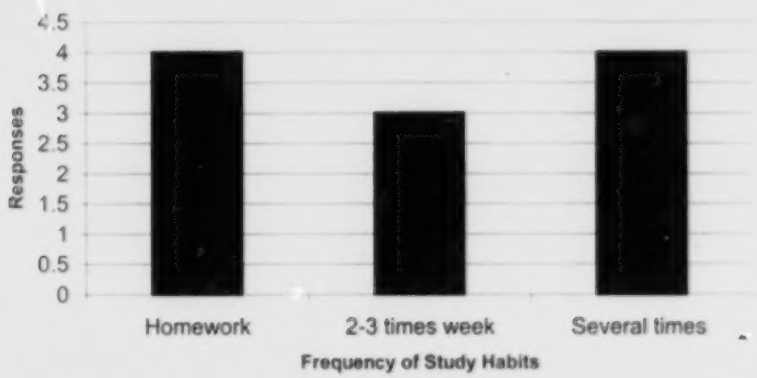


Figure 18. Parent survey responses for question one in classroom B2.

An analysis of the data suggests the greatest responses in homework as well as practicing math facts several times a week. It appears the students' greatest source for

assumes that parents have their children studying or doing homework at the kitchen table rather than in the living room or bedroom because of the distraction from a television.

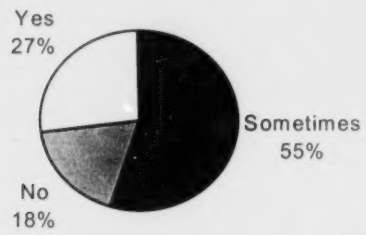


Figure 20. Percent of students needing help mastering math facts according to parent survey in classroom B2.

An analysis of the data suggests the most frequent reply on the parent survey was that students sometimes needed help mastering math facts. The category with 27% means parents responded they always help their child with mastering math facts. The category with only 18% indicates that parents said their students never needing help mastering their facts. The researcher assumes certain students practice on their own and use strategies to help them, whereas other students are given strategies by their parents. The data imply that the majority of the students need to be taught specific strategies to help master their math facts in order for quick recall.

Probable Causes

The literature suggested several underlying causes for low math achievement. One of the possible causes listed was too much content throughout the year that the teacher is in responsible for covering. Ineffective and inefficient teaching and no transfer

the opportunity to work on computation is homework and practice sheets, which are sent home several times a week. The data imply that students need to study their math facts more often than they are doing so. The students should study them at least 4-5 times per week for mastery.

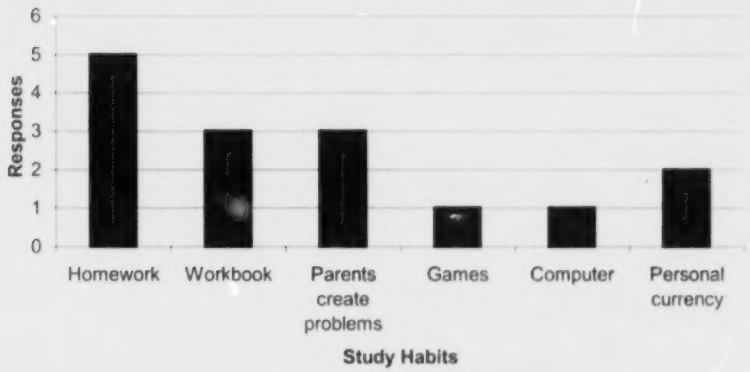


Figure 19. Parent survey responses for question two in classroom B2.

An analysis of the data suggests the greatest responses fell into homework. Parents responded to having their child do homework most often as a way of mastering math facts. Since students are given homework every night, the researcher assumes it is the easiest and most convenient way to study. An equal amount of responses were in the areas of workbook pages and math problems created by the parents, followed by using personal currency. Responses dropped in the areas of games and using the computer. The data imply that the majority of the students' only opportunity to study math facts is through doing their homework.

Out of 11 parent surveys, 8 parents responded that their child studied their facts at the kitchen table. Two parents responded that their child studied in the living room or bedroom and only one parent was uncertain where their child studied. The researcher

were the two next causes upon which researchers focused. These causes were focusing on the problem of teachers not teaching for mastery, and also not teaching their students how to transfer their knowledge of math facts into other areas of their lives. The last cause upon which the researchers focused on was the lack of memorization. Lack of memorization was a cause of low math achievement because the students need to focus on rote memorization as well as the conceptual understanding.

Too Much Coverage

The literature suggested that there is too much content to cover in the math curriculum. The Third International Mathematics and Science Study (TIMSS) states that curriculum studies found that American textbooks are much thicker that those in other countries and that, in attempting to get through them, teachers often cover topics briefly and superficially (Bracey, 2000, p. 473). Teachers felt students did not have enough time to understand a concept because less time was spent on drill, practice, and hands-on activities. Moving students to a new concept area before the majority of students have mastered the old leads students to failure. Many teachers would like to teach for mastery, but feel that they had to reduce their time due to deadlines in the curriculum (Bracey, 2000). The researchers understand this frustration due to the fact that there is too much information to be taught throughout the school year, and they are also struggling to teach everything successfully. The researchers believe the information needs to be consistently reviewed throughout the year in order for students to retain concepts. This is very difficult because the time frame for math does not allow one to complete all curriculum responsibilities as well as review. It is a struggle each day to try to teach a new concept

that includes modeling, skill and drill, hands-on practice, and literature, as well as time for review. The researchers believe these are all-important aspects for mastery.

Since teachers reduce the amount of class time spent on new information, students, as a result, have difficulty recalling information and attaching meaning (Ritchie & Karge, 1996). Even students who have strong math abilities and have a strong desire to learn suffer in these situations. These deadlines fail to consider the reduction in student understanding and comprehending material. Furthermore, teachers do not have time to teach students to elaborate on information or connect new information with already existing information. Once students have been taught elaboration, they can make connections, inferences, examples, and store it all into their long-term memory. Studies show that students who were taught this strategy and used it consistently scored higher on test scores than those students who did not. This study shows that this is a useful strategy that teachers should be incorporating with their students but do not because they feel a lack of time (Lombardi & Butera, 1998; Ritchie & Karge, 1996).

No Transfer

Students are failing to transfer math skills into other content areas as well as in real life (Perkins &Salomon, 1991). Students are not using the skills they have learned and transferring those skills into other content areas. For some reason, students see each content area as separate entities rather than a whole. They do not understand that the math skills they are learning can be applied to all aspects of their life. Students need to realize that what they learn in reading teaches them to understand other subject areas and what they learn in math is important for science or social studies. When students learn about correct grammar in English they need to know that correct grammar is expected in

all subjects not just English class. They do not make these connections on their own because they have never been taught them and many teachers do not explain this importance to their students. This poses a problem because most of what students learn in school needs to apply to real life. For example, when students learn specific math skills they should be able to transfer those skills into daily life such as making reasonable purchases, keeping track of their money, understanding mortgages, to name a few examples. It is not enough for students to receive good grades on tests and quizzes if no real life connections are made. This is the true reason students learn these skills. When this happens students have lost the reasoning and importance behind learning math (Bellanca, Costa, & Fogarty, 1992).

Perkins & Salomon (1992) believe some teachers use the "Bo Peep theory" in their teaching style. The "Bo Peep Theory" occurs when teachers believe transfer happens automatically, as though it takes care of itself. Teachers assume when they teach students a specific skill their students will apply it to other areas without being taught how. For example, when a teacher has just taught the students about math facts she assumes that students know that learning these facts help them in other subject areas and in life settings such as the grocery store. Instead, students probably do not see these connections and see these math facts as something that just need to be memorized. When they see the relevance of learning these math facts, it makes much more sense to them. They feel there is reasoning and importance behind spending so much time practicing. Teachers need to spend time in the classroom showing students how to apply specific math skills to other content areas and everyday throughout life through various examples and activities.

Mental computation is extremely important and has been undervalued and overlooked. Mental computation should be taught as a strategy that becomes natural for students at all times rather than as a set of rules. Eventually teachers want all students to master their facts without using pencil and paper (Mochon & Roman, 1998). A study conducted by Mochon and Roman gave 60 children a questionnaire and interviewed them on a number of arithmetic operations that were to be solved by mental computations. The results of their research found that they were reluctant to use mental computations and relied heavily on pencil and paper. The researchers believe that these students may not have been taught how to use mental computations. Teachers cannot expect students to use mental computations without being taught specific strategies. When teachers teach their students various strategies on how to retrieve math facts quickly and at ease they may begin to eliminate pencil and paper as well as their fingers because they feel confident and successful.

Lack of Memorization

Some researchers believe that rote memorization has an adverse effect on mathematical achievement. These researchers question whether it is developmentally appropriate to force lower elementary students to memorize basic math facts (Czuchry & Dansereau, 1998; Ferguson & Paulos, 2000; Isaacs & Carroll, 1999). Isaacs and Carroll state that rote memorization without thinking strategies can lead children down the wrong path. However they strongly believes in teaching students through manipulatives, patterns, and strategies. Although manipulatives are highly effective for students when learning math, it is essential that teachers explain to students why they are being used. Teachers may use manipulatives with their students, but not explain the reasoning behind

them. This leads students to rote learning without meaning. The following joke highlights this problem in a humorous way. A girl is learning to multiply using square blocks as manipulatives. The girl is showing an array of four blocks by six in a tray. A school inspector walks by and notices the girl working and compliments her. Then, he asks her what is four times six. She responds by telling him one six is six, two sixes are twelve, three sixes are eighteen, and four sixes are twenty-four. She tells him the answer is twenty-four. The inspector agrees that is the correct answer but wonders why she is stacking blocks in the tray. The child responds by telling him the teacher told her to (Derbyshire, 2000). This is a perfect example of children who might be using manipulatives, but are not quite sure why. They are only following the teacher's orders. If teachers use manipulatives as a learning tool, then students need to understand how they relate to their learning and why they are useful. Isaacs and Carroll also feel that timed tests are inappropriate because they lead to anxiety and lead students to believe that there is no thinking involved (1999). In order for student to recall information it is important that they are able to make connections within the brain. Rote memorization alone does not link the information together therefore the students may have difficulty retrieving information (Czuchry & Danserau, 1998).

Some researchers believe that there is too little emphasis on rote memorization. Although it is appropriate for teachers to address conceptual understanding of mathematics, it is equally important to focus on rote memorization strategies (Derbyshire, 2000; Ferguson & Paulos, 2000; Greene, 1985; Klien, 2000; Oladunni, 1998). Oladunni believes that students have a difficulty with computations because they have few problem solving techniques. He conducted a study in which the control group did not use any

problem solving techniques. These students rushed through their problems and did not use any problem solving techniques, and neglected using correct mathematical steps (1998).

Chapter 3

THE SOLUTION STRATEGY

Literature Review

The teacher-researchers focused on four areas during the literature search for solution strategies: revisiting and spiraling strategies, transfer strategies, effective and efficient teaching strategies and memorization strategies. After a thorough review of the literature on solution strategies, the teacher-researchers established project objectives to develop materials that foster memorization in mathematics and a series of learning activities, which address creative memorization strategies.

Revisiting and Spiraling Strategies

In a world where the amount of available information is estimated to double every five years, one of the most significant and controversial questions facing educators is the question: "What should all students learn?" (Cost, Bellanca, & Fogarty, 1992). Many of the current textbooks cover too much information. It has become very difficult for teachers to cover all the skills they are required to teach. As a result, the students receive a type of piece-meal education. Teachers spend a certain amount of time on a particular skill then quickly move to the next topic. Sometimes the information the child learns is never touched upon again.

According to much of the current brain research, if the students are not able to make connections to the information they are learning, the information will not be retained. The brain is a pattern-seeking mechanism and is constantly and continually searching for connections that makes sense. Classrooms in which themes are used frequently to connect ideas are seen to be more brain friendly than classrooms where information is doled out in discrete and separate pieces (Fogarty, 1997). Many textbooks do not chunk the material. Instead the material is covered in separate pieces. It may prove to be beneficial for the teacher to review what has been taught consistently throughout the year and to make the material relevant to the students.

Effective and Efficient Teaching Strategies

For children to develop a mastery of addition facts, efficient thinking strategies must be mentally accessible. Research clearly shows children's facility in basic facts is enhanced by their first developing effective thinking strategies. When the students are interested in their learning their achievement increases. It should be the goal of each first and second-grade teacher that every child in his or her classroom have available at least one effective strategy for any basic math fact (Leutzinger, 1999). Presenting activities that encourage children to think allows them to develop strategies at their own rates. These activities help children develop relationships among facts. They begin to view facts as related closely to other facts rather than as separate entities that must be learned independently. Some children need many such opportunities to incorporate strategies into their mental tool kit. By repeating these activities often for short periods of time, most children will become fluent in the use of the strategies. Once that fluency exists, the mastery of basic addition facts is made much easier (Leutzinger, 1999).

In the past, learning basic facts was often overemphasized, with too much class time spent on repetitive practice and too little time spent on exploratory experiences that gave children opportunities to develop efficient thinking strategies. Using a variety of teaching techniques such as cooperative learning, multiple intelligences, doubles, and counting on helps to maintain student interest and master math facts. Children should master the basic facts of arithmetic that are essential components of fluency with paper-and-pencil and mental computation and estimation. At the same time, however, mastery should not be expected too soon. Children will need many exploratory experiences and the time to identify relationships among numbers and efficient thinking strategies to derive answers to unknown facts from known facts (Klein, 2000).

Teachers need to have high expectations of the achievement of their students and provide incorporate instructional materials and technology of high quality that incorporate these challenging standards that are presently in place. If teachers do not expect quality from their students, then the students will only work toward these lower expectations. If teachers challenge their students by providing them with a stimulating and exciting curriculum, the students will almost always rise to the occasion. Activities outside the classroom that reinforce the classroom experience by drawing on the support of parents, the professional communities of mathematicians, scientists, and engineers, business leaders, and the broader public, should be taken advantage of. Teachers should also rely on community members to help reinforce mathematics concepts (An Action Strategy for Improving Achievement in Mathematics and Science, 1998).

Many textbooks and curriculums have physical movements attached to their strategies for learning a topic. Teachers should provide students with the opportunity to

become active learners and use movement (Sprenger, 1998). Music is another great way to get students' brains ready for learning and make them more enthusiastic to do so. Teachers can get their students together in small groups and have them invent their own lyrics about addition, subtraction which will help them remember what they learn. No matter which path is chosen, in order to be an efficient and effective educator a variety of teaching styles and assessments should be provided.

Transfer Strategies

Learning takes place best when new learning is connected to old learning. This will help the students see meaning and relevance, which, in turn, will form connections to other parts of the brain. Sousa (1992) believes there are eight strategies to improve student's retention of learning. The first strategy is teaching new learning at the beginning and end of a lesson because this is what they will remember most. The time in the middle of class should be used as a review. The second strategy is to find ways to connect their new learning with information they already know so they can make meaningful connections. For example, when teaching story problems teachers should include stories that relate to student interest. The third strategy is not to confuse the students with new learning. Teachers should find a variety of ways to help them relate this new learning to information they already know so it is not confusing to them. The fourth strategy is to provide verbal cues so students can make connections before storing into long-term memory. Teachers should try to explain concepts in different ways to assure all students understand the concept. Teachers should include students in questioning to help them understand more clearly. The fifth strategy is to use visuals such as charts, graphs, diagrams, or pictures. This will help visual learners recall information easier. The sixth strategy is not to teach too much new learning at one time.

Students may forget quickly. They need time to process and store new material before they are ready to move on. The seventh strategy is to practice material for short periods of time throughout the year rather than practicing immensely for a day or two. When learning is revisited on a regular basis in short time frames students' retention increases. The last strategy is to organize new material properly so it can be stored into long-term memory with ease. Helping students cluster ideas into groups makes connections easier. The researchers agree with these strategies because they have observed and used many of these strategies in the classroom. When teachers use these connections in math, students feel successful because it makes sense to them.

Teachers should not leave transfer up to the student. Teachers need to be active in making transfer relevant by using a connected curriculum where bridges are made between different subject areas and real life situations (Perkins & Soloman, 1992). The best way for students to understand is to make relationships and connections. The curriculum should be taught as a whole rather than separate entity. When teachers integrate, students develop a deeper understanding (Perkins, 1991). The researchers concur with the author because they recognize this in the classroom. When a certain topic is being taught and connections are made to other content areas, students seem to perform better and are more likely to participate. Fogarty (1997) states that most students do not understand how to transfer until it is taught to them because it is so complex. For example, if a student is learning about the periodic table and has no desire to go into a scientific career they will not see this as being useful to them. However, if teachers teach connections such as using a periodic table will help to analyze, describe, other graphs, they will find it much more useful because transfer has taken place. Other ways to help

students' transfer are teaching children metacognition, the ability to think about their own thinking, and showing application. When students are aware of their own learning they are able to plan, evaluate, and monitor information. Planning time needs to be allowed for students to self-monitor and self-evaluate their learning and to reflect. Application clearly shows students how learning is transferred from one context to another. When students apply what they have learned immediately after being taught, students are likely to retain and process into long-term memory.

Memorization Strategies

The only evidence we have of learning is memory. The brain has different areas to store the information we learn. We have separate storage areas for temporary memories and permanent memories. Teachers want learning to take place in the permanent storage areas. Within the brain's permanent storage there are five memory lanes. The five memory lanes are semantic, episodic, procedural, automatic, and emotional. The most powerful learning takes place in multiple memory lanes (Sprenger, 1999).

The semantic memory is one of the five memory lanes and is the memory people use to hold information learned from words. Semantic memory contains factual information. Semantic memory must be repeatedly processed to activate the long-term memory. The episodic memory is another one of the five lanes of memory and deals with locations. The episodic memory is important because you are always somewhere when you learn something. A person can easily associate learning with the location. The procedural memory is the memory lane that stores the processes that the body does. Procedural memory is often sequential. Automatic memory is the memory lane

associated with conditioned responses. Certain stimuli automatically trigger the memory. The final memory lane is the emotional memory. Emotional memory is very powerful and often takes over other memory lanes. When an emotional memory is triggered it releases chemicals that can alter a person's thinking (Sprenger, 1999).

Retrieving information from the brain is difficult because the information may be stored in the different memory lanes. The key to successful teaching is to access as many of the memory lanes as possible. The students will be able to recall information faster if they have a variety of ways to connect the information they are learning. There are creative ways to tap into the students' long-term memories. For example, when music is combined with learning our brains make emotional connections. These emotional connections allow us to recall information automatically (Sprenger, 1998).

Using music to enhance learning should not be overlooked. Not only does music enable the brain to store information in multiple lanes; it also allows the brain to use synapses that the brain might not ordinarily use. Synapses are what help the brain make connections. According to Norman Weinberger, synapses grow stronger through use and become weakened through disuse... by making music, we engage all these systems (1998). Ultimately, music is important in the memory process.

Another method of improving memorization is to spiral learning rather than cram learning into a single unit. The more the students practice what they are learning the better they will retain the information. Bernstein suggests, "distributed practice" yields better understanding and retention than "massed practice" (1996). For information to be retained in the long-term memory, it must be repeated. If the student learns the

information once during a "crammed" unit and is not consistently allowed to use the information she learned, the information will be lost.

Using mnemonic devises is an effective tool for memorization. Mnemonics is a system of memorization. Joyce, Weil, and Calhoun discuss how people who master material more quickly and who retain it longer generally use more elaborate strategies for memorizing material (2000). Mnemonics is more effective than rote memorization because it requires the brain to make more associations. Rote memorization is simply repeating the same thing over and over until it is stored in the brain. The additional associations, with mnemonics, provide a richer mental context, and the linking process increases the cognitive ability (Joyce, Weil, & Calhoun, 2000). An example of a mnemonic devise would be to teach the acronym HOMES to teach the names of the Great Lakes. Instead of repeating the names of the Great Lakes over and over, the student can remember one familiar word, HOMES, to assist with memorization. Any system of memorizing that uses multiple storage areas in the brain is advantageous.

The most effective teaching utilizes a wide variety of memorization strategies. When the students are able to connect the information they are learning to information already learned, they will better be able store the information in their long-term memory. Once the information is stored it is important for the teacher to provide opportunities to re-use the information learned. If the student is never asked to retrieve the information, it will be lost or distorted.

Project Objectives and Processes

As a result of increased instructional emphasis on creative memorization strategies, during the period of January 2001 to May 2001, the first and second grade students from the targeted classes will increase their ability to memorize math facts, as measured by Mad Minutes and teacher constructed tests.

In order to accomplish the project objective, the following processes are necessary:

1. Materials that foster memorization in mathematics will be developed.
2. A series of learning activities that address creative memorization will be developed for math facts.

Action Plan

The action plan will be targeting the first and second grade students in two separate districts. The teachers in these classrooms noticed their students struggling with their memorization of math facts. The two first grade classes are expected to know their sums to ten and their differences less than ten. The two second grade classes are expected to know their sums to eighteen and their differences less than ten. The goal of this action plan is to give the students strategies to help them solve math facts in a timely manner.

After reading a wide variety of literature on memorization of math facts, the researchers will be implementing the following interventions: Touch Math, Multiple Intelligences with a focus on Musical/Rhythmic and Bodily/Kinesthetic, and Mnemonics.

The Action Plan will consist of three interventions, each of which will be taught for four weeks, daily, and for 15 minutes per session.

Weeks 1 and 2

The researchers will collect baseline data using student checklist, parent survey, and Mad Minutes.

Weeks 3-6 - Touch,Math

Touch Math (2000) is a published program that helps teach the child how to calculate simple addition and subtraction problems through visual and tactile stimulation. The children use dots for visual stimulation and physically touch the dots with pencil for tactile stimulation.

Weeks 7-10-Multiple Intelligences

The next intervention will focus on Multiple Intelligences. While implementing all eight of the Multiple Intelligences, the researchers will concentrate on Musical/Rhythmic and Bodily/Kinesthetic. The students will listen to, sing songs, and use their bodies to learn addition and subtraction facts.

Weeks 11-14- Mnemonics

The final intervention will be Mnemonics. The researchers will teach different strategies to increase fluency and rapid recall of addition and subtraction facts.

Weeks 15 and 16

The researchers will collect post-data using student checklist, parent survey and Mad Minutes.

Methods of Assessment

The tools the researchers will use to gather data are Mad Minutes parent surveys, anecdotal records and student checklists. Mad Minutes will be given initially, after the

first six weeks, and at the end of the twelve weeks. The parent surveys and the student checklists will be given at the beginning and at the end of the research.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The objective of this project was to give the students strategies to help them solve math facts in a timely manner. The implementation of Mnemonics, Multiple Intelligences with a focus on Musical and Bodily/Kinesthetic, and Touch Math were selected to effect the desired changes. The researchers implemented the intervention for twelve weeks, four times a week for at least fifteen minutes. Each of the three interventions was taught at four-week intervals. The initial baseline data was collected through two Mad Minute tests, a student survey, and a parent survey. For the post data collection the same two Mad Minute tests were administered, and the same student survey was given. However, the parent survey was different, in order to determine whether the parents felt their child had improved their study habits. Original plans included testing the students using Mad Minutes after seven weeks, but the researchers felt that testing after seven weeks proved to be an inadequate time period to determine if the interventions were effective.

Touch Math was used to teach concepts through a kinesthetic approach that would eventually segue into the abstract understanding of the concepts being taught.

The classes began Touch Math by learning the placements of the dots on the corresponding number. The students learned the placement of the dots on the numbers one through nine. They practiced touching and counting the dots on the numbers. Once the students accomplished this task, they began using this strategy to solve simple addition and subtraction problems. Touch Math provided a visual cue for counting, and helped the student rely less on their fingers and number lines.

Multiple Intelligences was another focus of the intervention. An emphasis was placed on Musical/Rhythmic and Bodily/Kinesthetic. The students listened and sang to a variety of addition and subtraction songs. While the students sang along to the music, they worked on a corresponding practice page to reinforce the skills mentioned in the song. The songs started with simple adding-on strategies and then progressed to more complex strategies such as doubles and missing addends. For Bodily/Kinesthetic the students solved math equations using their bodies. For a problem like three plus three, there would be three students on one side of the addition sign and three students on the other side. The students then solved the equation by moving to the equal sign.

The final intervention used was Mnemonics. The students were taught a variety of addition and subtraction strategies that provided easier and faster ways to solve computations. Some of the strategies were doubles plus one, making ten, and using patterns.

Presentation and Analysis of Results

In order to assess the effects of the three interventions: Touch Math, Multiple Intelligences and Mnemonics, a Mad Minute test was given prior to and after the interventions. These results are shown in Figures 21 through 29.

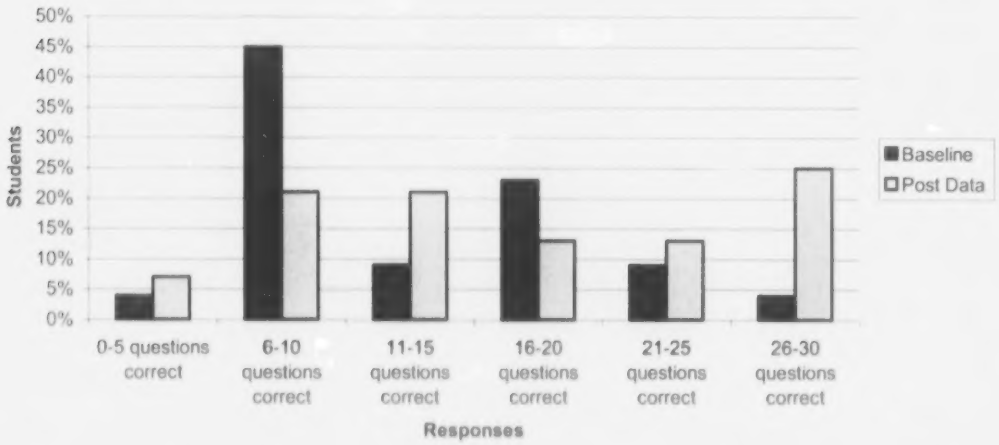


Figure 21. Percent of correct responses for Pre and Post Mad Minutes (Addition) in classroom A1.

When the baseline test was first administered the above results show forty-five percent of the students falling within the 6 to 10 correct category. Post data results however show marked differences with only twenty percent of students falling in the 6 to 10 range while numbers in the 26 to 30 category rose approximately twenty-one percent. Further post data results show that roughly fifty percent of the students correctly answered 16 or more questions and illustrates a rather even distribution of scores.

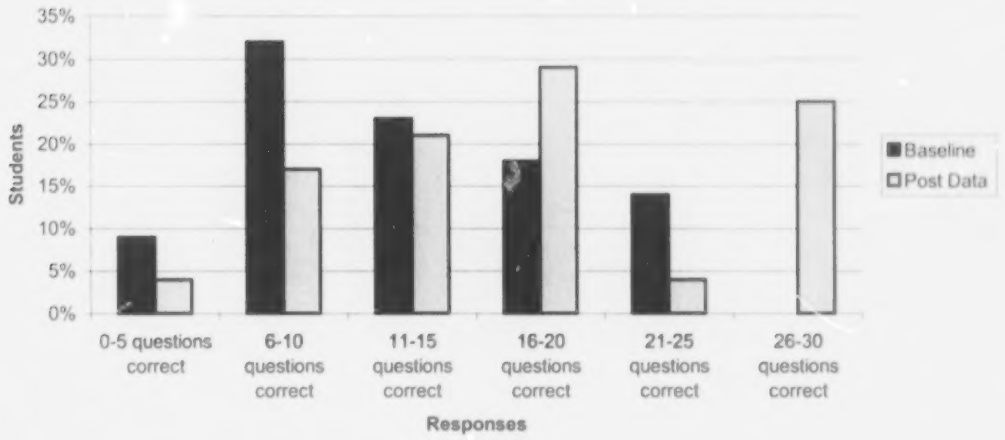


Figure 22. Percent of correct responses for Pre and Post Mad Minutes (Subtraction) in classroom A1.

Analyses of the data show a significant improvement in retention of subtraction facts. In the baseline data none of the students answered 26-30 out of the possible 30 questions correctly. In the post data 25% of the students were able to answer 26-30 problems correctly. Almost 60% of the students answered more than half of the problems correctly on the post data. This is a marked improvement from the baseline data. It seems an anomaly that so many students would fall into the 26 – 30 range in the post data analysis. Experience has shown this researcher that subtraction tends to be a more difficult concept for students to grasp.

After students completed the interventions, they were given the same Mad Minute that was used for baseline data. The researcher in classroom A2 administered the Mad Minute to 17 second grade students. Each student had two minutes to solve as many problems as they could in any order. The pre and post data for addition facts is shown in Figure 23.

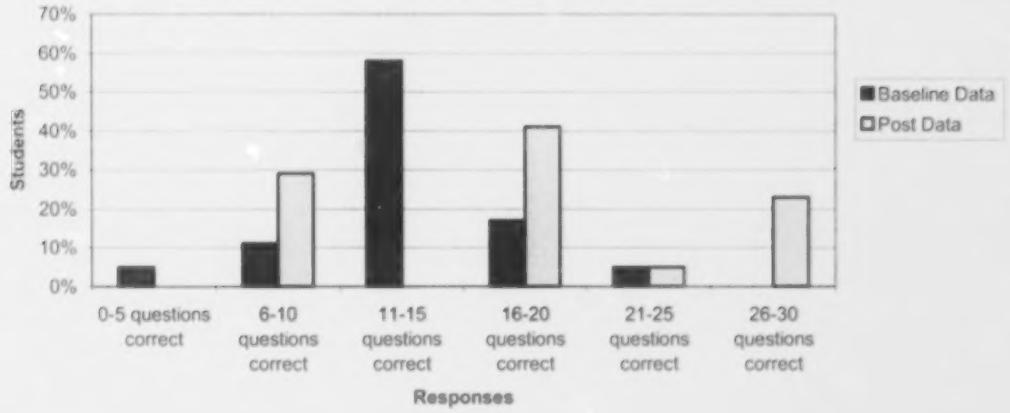


Figure 23. Percent of correct responses for Pre and Post Mad Minutes (Addition) in classroom A2.

The interventions used by the researcher appear to have had a positive effect on the students. In the post data, nearly 25% completed 26-30 compared to 0% in the baseline data. Those students who only completed 0-5 questions correct had increased their scores. Overall, students' rapid recall of math facts has increased throughout the 12 weeks of interventions. However, in order for students to continue to increase their retention of math facts, the researchers believe they need to continue practicing on a regular basis.

After students completed the interventions they were also given the same subtraction Mad Minute as used in the baseline data. Each student was given two minutes to complete as many subtraction problems in the allowed time. The data were collected and are shown in Figure 24 for classroom A2.

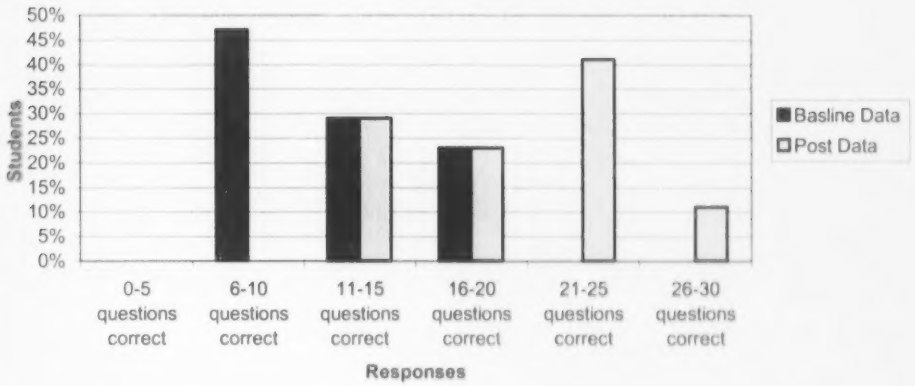


Figure 24. Percent of correct responses for Pre and Post Mad Minutes (subtraction) in classroom A2.

The interventions used by the researcher appear to have helped children improve their rapid recall of subtraction facts. More than 50% of the students completed 21-30 questions correctly in the two-minute time compared to 0% in the baseline data. None of the students completed less than 11 questions correctly. In addition to the interventions taught to them, students need to continue to practice these math facts on a regular basis.

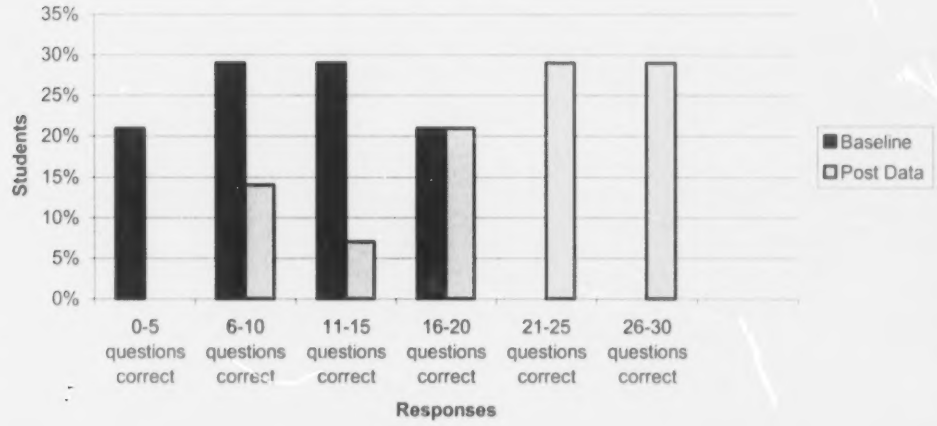


Figure 25. Percent of correct responses for Pre and Post Mad Minutes (Addition) in classroom B1.

The data imply that the addition test scores improved greatly from the beginning of the action research. Over 75% of the students correctly answered fewer than half of the questions when the test was first administered. When the test was administered for a second time the test scores dramatically improved with, over 75% of the students correctly answering more than half of the questions. The data also show that almost 60% of the students correctly answered at least twenty questions when previously no one in the class had correctly answered more than twenty questions. Another interesting finding is that nearly 45% of the class correctly answered ten questions or less the first time they took the test, while fewer than 15% of the class correctly answered only 10 questions or less the second time the Mad Minute test was taken.

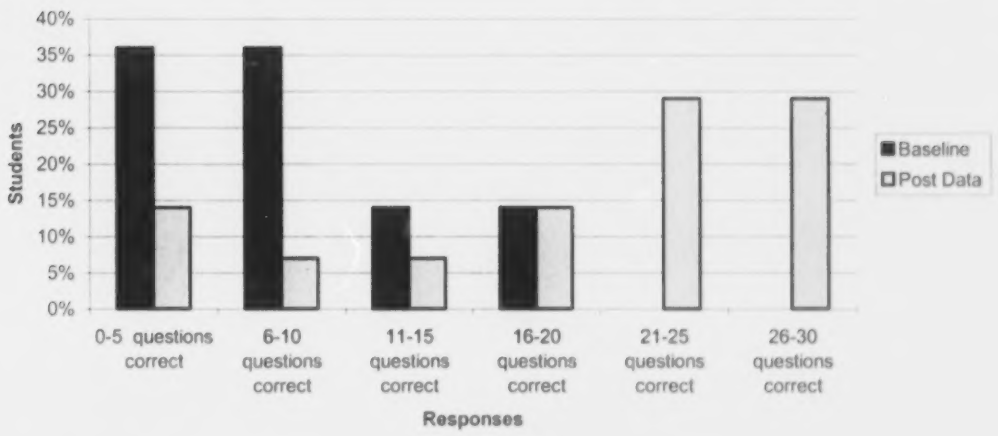


Figure 26. Percent of correct responses for Pre and Post Mad Minutes (Subtraction) in classroom B1.

The data show that the subtraction Mad Minute test scores improved dramatically. Over 80% of the students correctly answered fewer than half of the questions on the first Mad Minute test given, while on the post Mad Minute test over 75% of the student correctly answered more than half of the test correct. Only 25 % of the students answered less than half of the questions correct this are down from over 80% of the students on the pre Mad Minute test. On the first Mad Minute test no student correctly answered more than twenty questions. However, on the second Mad Minute test almost 60% of the student correctly answered over twenty questions. The data imply that there was a dramatic improvement from the first Mad Minute test to the second Mad Minute test.

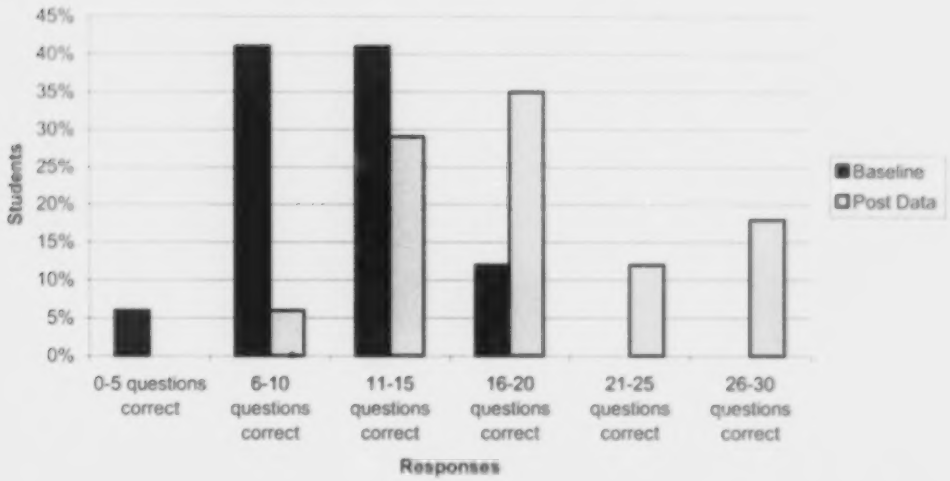


Figure 27. Percent of correct responses for Pre and Post Mad Minutes (Addition) in classroom B2.

The post data suggest that the Mad Minute test scores in addition show a great amount of improvement compared to the beginning of the action research. Over 80% of the students answered less than half of the questions correctly when the test was first administered. When the test was administered for a second time the test scores improved with over 65% of the students answering more than half of the questions correctly. The data also show that almost 20% of the students were able to answer between twenty-six and thirty questions correctly when previously they were not able to do so. The first time the test was given less than 15% of the class were able to answer at least twenty questions correctly, but the second time 35% of the class were able to do so.

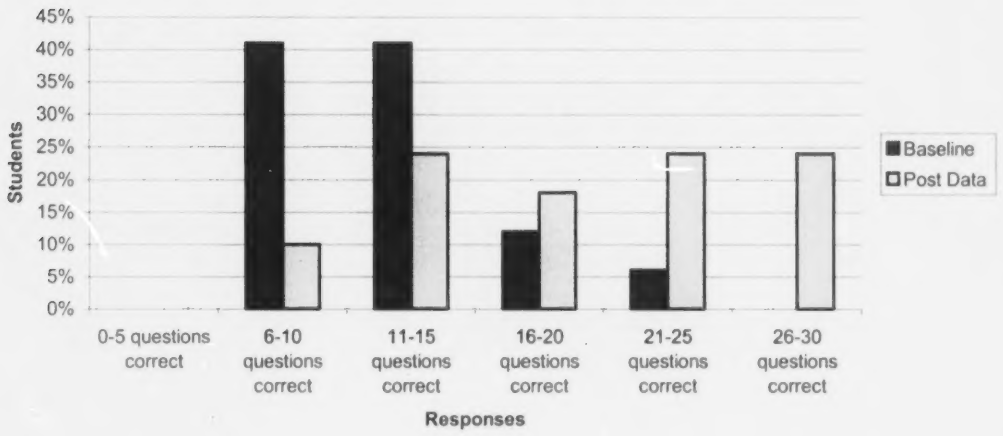


Figure 28. Percent of correct responses for Pre and Post Mad Minutes (Subtraction) in classroom B2.

The data show that the Mad Minute test scores for subtraction greatly improved in comparison to the beginning of action research. Over 80% of the students were unable to answer more than half of the questions correctly on the first test given, but on the post test more than 60% of the students were able to answer more than half of the questions correctly. Almost 50% of the class were able to answer 21 to 30 questions correctly post Mad Minute test, whereas only 6% were able to do so on the first test. The data imply that there was a dramatic improvement post research with the students' ability to answer their math facts quickly in comparison to what they could do at the beginning of research.

In order to assess student study habits and strategies they used to solve computation problems, a student survey was conducted and the results are shown in Figures 29 through 32.

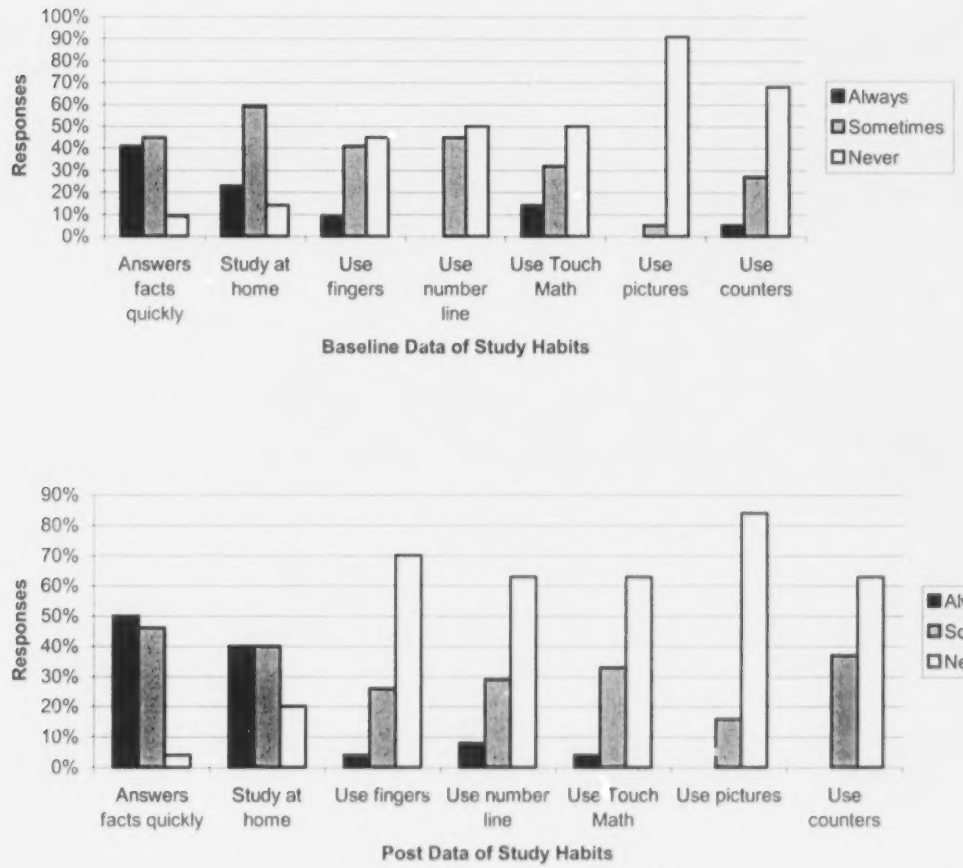


Figure 29. Student survey responses in classroom A1

While there is not much change between the baseline and post data graphs, there is an indication that more students are utilizing more of their intelligences during the learning process. The base line graph demonstrates that use of Touch Math, pictures, and counters were not as prevalent. In the past the students placed a focus on other methods of learning. However, as the post data graph indicates, after the intervention, students began to incorporate pictures, counters, and Touch Math as well.

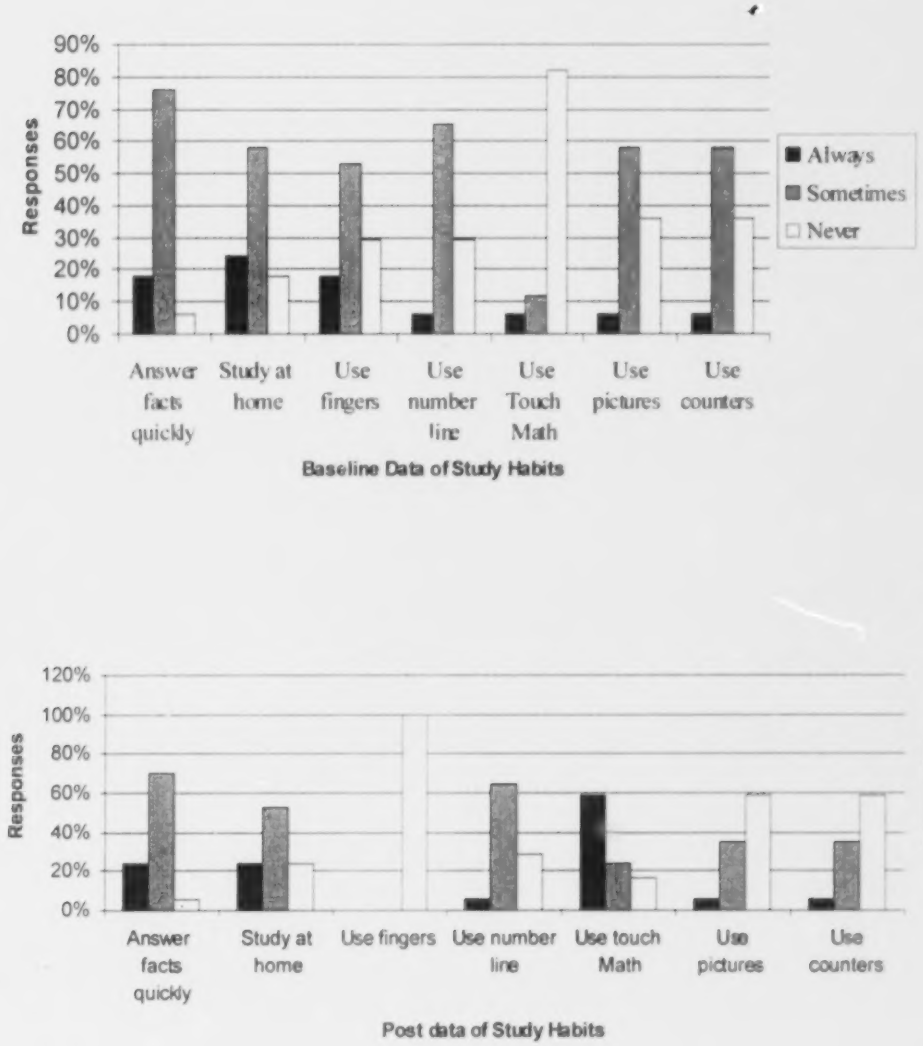
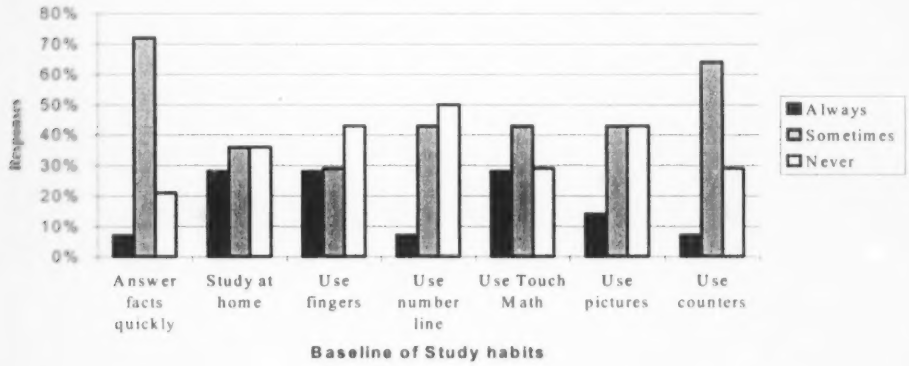


Figure 30. Student survey responses in classroom A2

Seventeen second graders in classroom A2 completed the pre and post student surveys. The survey consisted of 7 items that were discussed and clarified for all students in January and again in April. A summarization of the results is presented in Figure 30. Most students responded differently in April than in January. In April all students responded they never use fingers anymore, compared to about half confessing they used

them sometimes in January. Also, most of the students responded they use touch math, and fewer students responded to using pictures and counters to help them. More students responded to answering the facts quickly in April than in January. Surprising to the researcher, there was little change in whether students studied their facts at home.



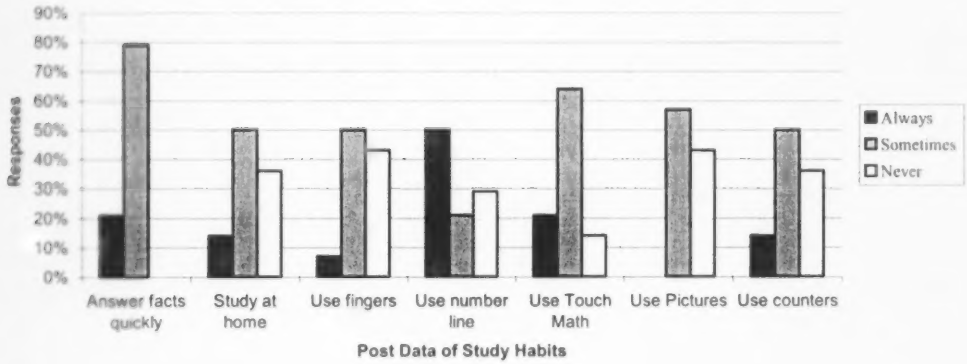


Figure 31. Students survey responses in classroom B1.

The researchers found that there was little change in the post student survey compared to the baseline student survey. While the data show that fewer students said they always use their fingers, the data also show that more students use the number line, Touch Math, pictures and counters. Few responses showed the strategies were always being used, but more often the strategies were sometimes being used. This leads the

researchers to believe that the students are using a variety of the strategies to solve the math computation. Many students in the first survey felt that they answered the math computations quickly, but said in the second survey that sometimes they answered the math computations quickly. The researchers were slightly concerned about the drop in students who studied at home. Nearly 30% of the students in the first survey replied that they always studied at home, but in the second survey only 10% of the students replied that they always studied at home.

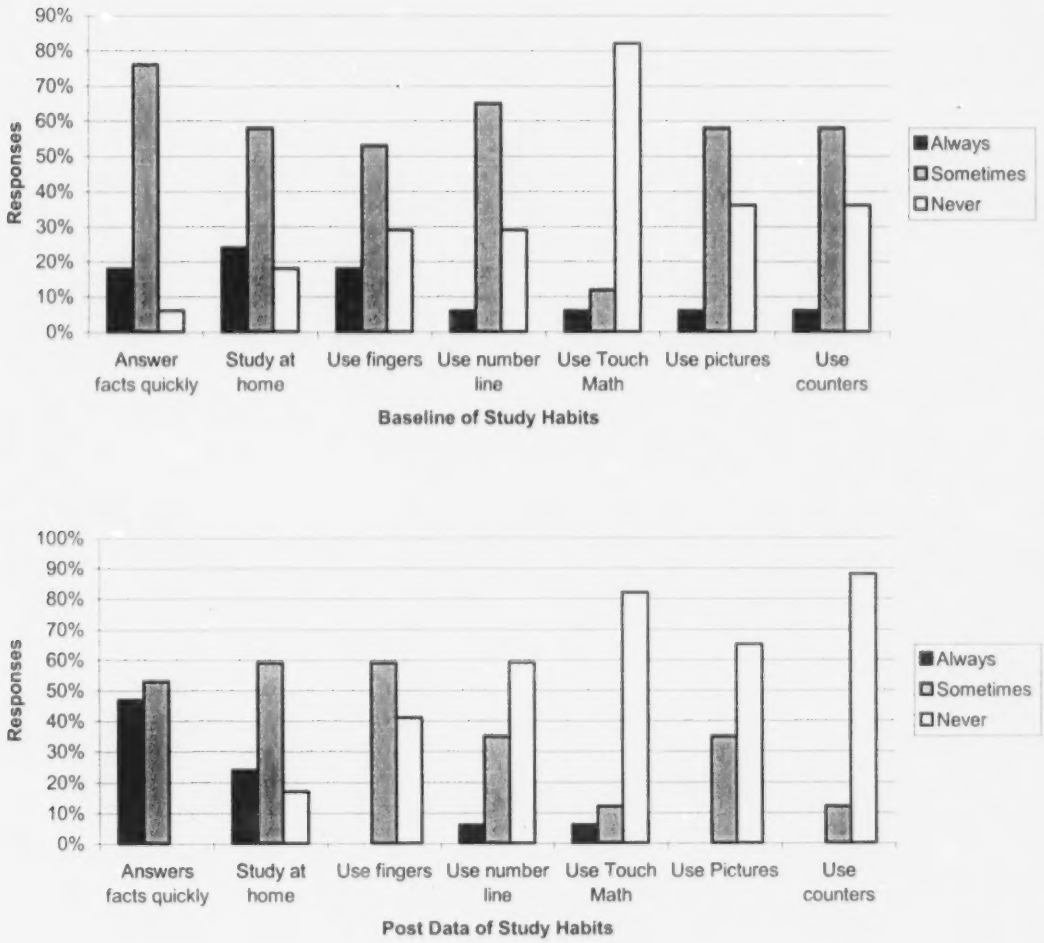


Figure 32. Student survey responses in classroom B2.

The data suggest that the students felt more confident in their math skills at the end of the project than before. Almost 50% of the students felt they could answer their math facts quickly in post data compared to less than 20% of the students' answering this way in baseline data. The number of students who sometimes study at home increased to almost 60%, whereas the percentage of students who answered always and never for the baseline data remained the same. There was a dramatic decrease in the percent of students who used their fingers. The same number of students did or did not use Touch Math. However it was interesting to see the increase in the number of students who felt they either no longer needed to use number lines, pictures, or counters to solve their math problems. The teacher-researcher believes the students' math abilities and their confidence in them drastically improved during this project.

In order to assess parent awareness of their child's study habits and how often they transfer their math knowledge to other situations or in community situations, a parent survey (Appendix G) was administered and the results are stated below.

Many of the parent surveys in classes A1 and B1 were not returned to the teacher researchers. Because of this lack of participation the results from the surveys are limited.

Question one asked the parents whether they noticed a significant change in their child's study habits. The majority of the responses in classes A1 and B1 were that the parents did not notice a difference in their child's study habits. Of the parents who did not see a difference in their child's study habits, many of the parents comments did not go into detail about the lack of change in their child's study habits. The parents who responded that they did see a change in their child's study habits were much more descriptive in their comments. These parents felt that their children were more eager to

study, concentrated more, and grasped math concept easier and improved in speed and accuracy.

Question 2 asked the parents if they noticed their child using fingers or manipulatives more or less than in the past. In classroom A1 the majority of the parents noticed that their child was using fingers or manipulatives less than in the past. Two of the responses did not notice any change and one response was a parent who stated that her child used his fingers more. Although in the pervious questions, the parents did not notice a difference in study habits here they did see improvement in the use of manipulatives. The students are able to do more math in their heads without the use of learning aides. In classroom B1 the majority of the parents noticed that their child used their fingers and manipulatives less than before the intervention. One parent stated that their child enjoys using the Touch Math technique to help solve problems. Another parent stated that their child had a better understanding about math.

Question 3 asked the parents if their child was using math skills in the community. In the classroom A1 all but one of the students were using math around the community. In fact one parent noticed her child computing prices and change in the grocery store and attempting to figure out baseball statistics. As with classroom A1 all but one parent in classroom B1 noticed that their children were using math around the community. Two parents stated that their children used math more around their younger sibling. Two more parents commented that their children now used their math knowledge anytime they find numbers around them.

The researchers in classroom A2 and B2 reviewed and analyzed the results of the parent survey responses. Overall, the survey stated an improvement in their child's math

ability. More than half of the parents stated that their child's study habits changed for the better. Some felt their child was more independent, confident, and less frustrated about math. A few parents felt their children were always good at math; therefore, they did not notice any change. More than 85% of parents felt their child used their fingers less and a small percentage stated that their child had never used their fingers. When asked if parents noticed their child using math in their community almost 90% of parents felt they were. Some examples stated in the survey were counting money, telling time, cooking and sports. Nearly 10% of parents stated they did not notice their child applying their knowledge in the community.

Conclusions and Recommendations

Based on the presentation and analysis of the data on creative memorization, the students showed an improvement in math achievement. Incorporating Touch Math, multiple intelligences, and mnemonics appear to have increased the ability of the students to retain their math facts. The amount of time and the use of manipulatives when calculating math facts were decreased.

Touch Math worked well with the lower achieving students in both the first and second grade classrooms. However, the high achieving students did not need to use Touch Math as an aide for memorization. The second grade teachers discovered that Touch Math was not as useful for retention with math problems with higher sums and differences. The students used alternative strategies for solving those problems. Problems with higher sums and differences had too many touch points. It was easier for the students to use mnemonics.

The researchers agree that Touch Math was successful with the students who have difficulty learning their math facts because it enables the students to bring an abstract concept, such as numbers as a symbol for quantity, into a more concrete form. The students are physically touching the touch points on the numbers making it more concrete. Eventually, the researchers hope that the students will no longer need to use Touch Math as a crutch for learning. It should be used after the students understand the concepts behind addition and subtraction. Once the students understand the concept, Touch Math should be used to assist in memorization.

Multiple intelligences proved to be beneficial for a majority of the students in all the classrooms. Although the researchers tried to incorporate all the intelligences into their teaching, they focused primarily on the musical/rhythmic intelligence and the bodily/kinesthetic intelligence. The musical/rhythmic intelligence is most useful for students who are sensitive to sounds. These students love to listen to music. Listening to the math facts on tapes and CD's taps into the students' love of music. For many of the students combining music and math helped to foster a positive attitude in math because it made, an otherwise difficult subject, exciting for all grade levels. In fact, the teachers in the first grade classrooms found their students singing the math songs outside of the classroom.

The bodily/kinesthetic intelligence has the students using their bodies and other manipulatives to solve math problems. Students who learn best through the bodily/kinesthetic intelligence like to move around and feel the need to,physically manipulate the world around them. There is some information that is better expressed

physically than in any other way. Learning sports is a great example of memorizing through movement.

Learning math facts through movement is often overlooked. The first graders enjoyed learning their math facts by acting out the problems. Younger students need to express themselves through movement. The second graders did not need to physically move their bodies to help them retain their math facts. All of the classrooms benefited through using other types of manipulatives. Similar to Touch Math, the researchers believe using manipulatives is an excellent way to help with memorization in the beginning, but they would like to see their students gradually decrease the use of manipulatives.

Multiple intelligences is an excellent teaching tool. Every person is unique and every person has a style, in which he or she learns best. The researchers recommend using multiple intelligences as a way to reach as many students as possible. Children are not familiar with which style they learn best. It is the teacher's responsibility to help the students discover how they learn.

Mnemonics is another strategy for memorization. Mnemonics gives students a variety of memorization "tricks" to add to their learning repertoire. The researchers taught their students catchy phrases to help the students memorize the math facts. The second graders found mnemonics to be extremely helpful, while the first graders became confused. Mnemonics was too complex for the first graders. The second graders liked using mnemonics because it was challenging and it required them to use higher level thinking. The most common strategies the second graders used were "doubles plus one" and "make a ten." There were a few second graders who found mnemonics too difficult.

The researchers will continue to utilize the interventions mentioned and will continue to monitor the progress made by the students. Overall, the interventions had a positive impact on math achievement and created a comfortable learning environment.

References

Addition & subtraction rock. (1993). Conroe, TX: Rock 'n' Learn.

Bernstein, B. (1996). "Cramming" vs. distributed learning. The High School Magazine, 45-46.

Boyle, J.R. (1997). Blueprints for learning. Teaching Exceptional Children, 29-34.

Bracey, G. W. (1996). Asian and American schools again. Phi Delta Kappan, 77 (9), 641-644.

Bracey, G.W. (2000). Trying to understand teaching math for understanding. Phi Delta Kappan, 81 (6), 473-475.

Bullock, J. (2000) Touch Math: Multi-sensory math supplement. Colorado Springs, CO: Innovative Learning Concepts.

Cheek, J.M. & Smith, L.R. (1999). Music training and mathematics achievement. Adolescence, 34 (136), 759-761.

Czuchry, M. & Dansereau D.E. (1998). The generation and recall of personally relevant information. The Journal of Experimental Education, 66 (4), 293-315.

D'Arcangelo, M. (2000). How does the brain develop? Educational Leadership, 58 (3), 8-13.

Dean, W.J. (1998). He had my number: No numbers, please. Christian Science Monitor 91 (13), 19.

Derbyshire, J. (2000). The hardest 'r'. National Review, 52 (10), 27-29.

Ediger, M. (1998). Sequence in primary grade mathematics. Journal of Instructional Psychology, 25 (3), 203-209.

Ferguson, T.W. (2000). Math myopia. Forbes, 165 (2), 36.

Fogarty, R. (1997). Brain Compatible Learning. Arlington Heights, IL: Skylight Training and Publishing.

Gable, R.A., Hendrickson, J.M., & Shellady, S. (1992). Strategies for improving maintenance and generalization of academic skills-So students "Don't leave class without it". Preventing School Failure, 37 (1), 35-40.

Gardner, M., Fox, A., Knowles, F., & Jeffrey, D. (1996). Arts improve reading and math. Teaching Music, 4 (2), 8-9.

Greene, G. (1995). Math-facts memory made easy. Arithmetic Teacher, 21-25.

Hartmann, J. (1998). Math all around me. Hop 2 it Music.

Heller, L.R. & Fantuzzo, J.W. (1993). Reciprocal peer tutoring and parent partnership: Does parent involvement make a difference? School of Psychology Review, 22 (3), 517-535.

Hill, L. (1997). Just tell us the rule: Learning to teach elementary mathematics. Journal of Teacher Education, 48 (3), 211-222.

Holden, C. (1999). Music as brain builder. Science, 283 (5410), 2007.

Isaacs, C., & Carroll, W. (1999). Strategies for basic-facts instruction. Teaching Children Mathematics, 5 (9), 1-17.

Joyce, B., Marsha, W., & Calhoun, E. (2000). Models of Teaching. Needham Heights, MA: Allyn and Bacon.

Kantrowitz, B., & Wingert, P. (1991). A dismal report card. Newsweek, 117 (24), 64-68.

Klein, D. (2000). Math problems. American School Board, 52-55.

Kolstad, R. K., & Hughes, S. (1994). Teacher attitudes toward mathematics. Journal of Instructional Psychology, 21 (1), 44-48.

Koustos, J. (2000). Making the right connection. National Education Association, 26-27.

Leutzinger, L.P. (1999). Developing thinking strategies for addition facts. Teaching Children Mathematics, 6 (1), 14-18.

Lewis, A. C. (1991). Math skills. Education Digest, 56 (8), 55-56.

Lombardi, T., & Butera, G. (1998). Mnemonics: Strengthening thinking skills of students with special needs. The Clearing House, 71 (5), 284-286.

Marsh, A. (1999). Can you hum your way to math genius? Forbes, 163 (8), 176-178.

Mastropieri, M.A., & Scruggs, T.E.(1998). Enhancing school success with mnemonic strategies. Intervention in School and Clinic, 33 (4), 201-207.

May, L. (1997). Mastering addition and subtraction facts. Teaching K-8, 28 (3), 14.

May, L. (1998). Practice makes perfect. Teaching PreK-8, 29 (1), 28-29.

Megnin, J.K. (1995). Combining memory and creativity in teaching math. Arithmetic Teacher, 33 (4), 21-25.

Mochon, S., & Roman, J. V. (1998). Strategies of mental computation used by elementary and secondary school children. Focus on Learning Problems in Mathematics, 20 (4), 35-49.

Morse, S.C. (1992). The value of remembering. Thrust for Educational Leadership, 35-37.

Norwood, K.S. (1994). The effect of instructional approach on mathematics anxiety and achievement. School Science & Mathematics, 94 (5), 248-255.

Okpala, C.O., Smith, F., Jones, E., & Ellis, R. (2000). A clear link between school and teacher characteristics, student demographics, and student achievement. Education, 120 (3), 487-495.

Oladunni, M.O. (1998). An experimental study on the effectiveness of metacognitive and heuristic problem solving techniques on computational performance of students in mathematics. Mathematics Education, 29 (6), 867-874.

Perkins, D.N. (1991). Educating for Insight. Educational Leadership 49 (2), 87-91.

Perkins, D.N. (1988). Teaching for transfer. Educational Leadership 46 (1), 97-106.

Peterson, P., & Swing, S. (1988). Elaborative and integrative thought processes in mathematics learning. Journal of Educational Psychology, 80 (1), 54-66.

Play M4: Mystery mental math minutes. (1999). Curriculum Review, 39 (3), 6-8.

Riesenmy, M.R., Mitchell, S., & Hudgins, B.B. (1991). Retention and transfer of children's self-directed critical thinking skills. Journal of Educational Research, 85 (1), 75-86.

Ritchie, D., & Karge, B.D. (1996). Making information memorable: Enhanced knowledge retention and recall through the elaboration process. Preventing School Failure, 41 (1), 39-44.

Semb, G.B. (1994). Knowledge taught in school: What is remembered? Review of Educational Research, 64 (2), 253-286.

Site A Report Card (2000)

Site B Report Card (2000)

Sousa, D.A. (1992). Helping students remember what you teach. Middle School Journal, 71-74.

Sprenger, M. (1998). Memory lane is a two-way street. Educational Leadership, 17-27.

Sprenger, M. (1999). Learning & memory: The brain in action. Alexandria, VA: Association for Supervision and Curriculum Development.

Tankersley, K. (1993). Teaching math their way. Educational Leadership, 50 (8), 12-13.

Teachers college record. (2000). Instructional Policy and Classroom Performance, 102 (2), 329-331.

Thompson, K. M. & Thompson, K. M. (1995). Twin Sisters Productions: Addition and Subtraction.

Thorpe, J. A. (1999). Subcommittee on basic research committee on science U.S. House of Representatives. [On-line]. Available: http:/www nctm org/news/testimony htm

Tribune (2000). Homes. [On-line]. Available: http:/www.tribunehomes.com.

Village Profile (2000). Community Profile Network. [On-line]. Available: http:/www.villageprofile.com

Weinberger, N.M. (1998). The music in our minds. Educational Leadership, 56 (3), 36-40.

Whitin, D.J. (1997). From other Publishers. Teaching Children Mathematics, 3 (7), 416-417.

APPENDICES

Appendix E

Student Survey

1. Can you answer your math facts quickly?	**A**	**S**	**N**
2. Do you study your math facts at home?	**A**	**S**	**N**
3. Do you use your fingers to solve math facts?	**A**	**S**	**N**
4. Do you use a number line to help you solve math facts?	**A**	**S**	**N**
5. Do you use Touch Math to help you solve math facts?	**A**	**S**	**N**
6. Do you use pictures to help you solve math facts?	**A**	**S**	**N**
7. Do you use counters to help you solve math facts?	**A**	**S**	**N**

Key: A- Always

S- Sometimes

N- Never

Appendix F

Parent Survey

1. At home, how often does your child study math facts per week?

2. How does your child study math facts at home?

3. Where does your child study math facts at home?

4. Does your child require help mastering math facts? If so, what techniques do you use to help them?

Appendix G

Parent Survey

1. Has your child's study habits changed since the Action Research project began? If so, how?

2. Have you noticed your child using their fingers or manipulatives more or less than in the past?

3. Is your child applying his/her knowledge of math facts in the community?